CONSTRUCTION MANAGEMENT (CM) METHODS AND THEIR SUITABILITY FOR USE IN U. S. NAVY CONTRACT CONSTRUCTION.

James Anthony Broaddus

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This thesis is dedicated to the memory of
CAPT Thomas J. Mitchell CEC USN
CDR Leland R. Dobler CEC USN
LT Charles H. Jefferies CEC USN
who were killed in the line of duty
on 13 April 1974 at the
U. S. Naval Base, Subic Bay,
Republic of the Philippines

CONSTRUCTION MANAGEMENT (CM) METHODS AND THEIR SUITABILITY

FOR USE IN U. S. NAVY CONTRACT CONSTRUCTION

by

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THESIS

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NAVAL FACILITIES ENGINEERING COMMAND

(Headquarters and Field Activities)

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CDR D. E. Bottorff	LCDR E. J. Lowery	LTJG J. D. Shaw
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A B S T R A C T

The purpose of this thesis is the examination of the suitability of the construction management approach for use by the U.S. Navy in their military construction program. A systems analysis approach was used in developing the topic because the system of facility production within the Navy is a complex one and the application of a technique like construction management to this system could create significant impacts on the entire process. In this paper the goals and objectives of the Navy's military construction program are presented as well as the existing system that implements the program. The performance of the existing system is also discussed. Then construction management alternatives are explored and the performance of these alternatives as now used by governmental agencies is presented. Hypothetical application of construction management to the Navy's construction program is demonstrated through the use of model systems and the effects on the system as a whole are discussed. The thesis concludes with recommendations concerning the further pursuit of this topic.

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GLOSSARY

ACI	American Concrete Institute
AE	Architect Engineer
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AROICC	Assistant Resident Officer in Charge of Construction
ASC	Armed Services Committee of Congress
ASCE	American Society of Civil Engineers
ASPR	Armed Services Procurement Regulation
ASTM	American Society of Testing Materials
BFRL	Basic Facility Requirements List
CEC	Civil Engineer Corps
CM	Construction Management
CMCS	Construction Management Control Systems
CNO	Chief of Naval Operations
CPM	Critical Path Method
CQC	Contractor Quality Control
CWE	Current Working Estimate
DD 1390	Activity MILCON Program Summary
DD 1391	MILCON Project Data Sheet
DD 1391C	MILCON Project Facilities Study
DOD	Department of Defense
EFD	Engineering Field Division of the Naval Facilities Engineering Command
EIC	Engineer in Charge
FBF	Federal Building Fund
GMP	Guaranteed Maximum Price
GSA	General Services Administration
HEW	Department of Health, Education and Welfare
IFB	Invitation for Bid
IRV	Item Rating Value

LSR	Logistics Support Requirement
MILCON	Military Construction Program
MILCON PO	Military Construction Program Objectives
NAVCOMP	Comptroller of the Navy
NAVFAC	Naval Facilities Engineering Command
NMCRB	Naval Military Construction Review Board
NSPE	National Society of Professional Engineers
OASD(I&L)	Assistant Secretary of Defense for Installations and Logistics
OICC	Officer in Charge of Construction
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense
PBS	Public Building Service
PD	Project Director
PM	Project Manager
ROICC	Resident Officer in Charge of Construction
SBA	Small Business Administration
SEABEES	Naval Construction Forces
SECNAV	Secretary of the Navy
SIFPPS	Shore Installations and Facilities Planning and Programing System
SIOH	Government Supervision, Inspection and Overhead

CHAPTER 1

INTRODUCTION

1.1 General

The term "construction management" (CM) is a "buzzword" within construction circles which is being used more and more frequently. Readers of the construction industry trade journals cannot help noting the published claims of success of projects performed through the use of CM

(1) A $12 million, eleven building classroom and laboratory health sciences complex completed in 1970 at the Stony Brook Campus of New York State University in less than nine months after signing of the architectural contract.[1]

(2) A $21 million, seven story graduate laboratory at Stony Brook occupied 21 months after the architect was commissioned.[2]

(3) The $22 million expansion to the Greater Cincinnati Airport to be completed in 33 months claims to be delivered 55 percent cheaper and three years faster than similar facilities provided in a conventional manner.[3]

(4) A $40 million, 1.2 million sq. ft. office building built in Dallas, Texas in 24 months - a time saving of 12 months.[4]

These quotes are likely to be viewed with great enthusiasm by those frustrated by the traditional methods of converting a facility requirement into concrete and steel. Those who have become seasoned veterans in the construction business and who are less idealistic will naturally look upon such published claims with a degree of skepticism. Since many of these construction "vets" occupy vital roles in the industry, their skepticism is understandable, for adoption of any of the CM techniques could have significant impacts on their own organizations as well as the whole construction business. Thus, CM deserves close scrutiny as to what it is,

what it can accomplish and what its potentialities are if decision-makers are going to effectively evaluate this alternative system of procuring construction.

1.2 Construction Management - The Term

What is construction management? This is a very difficult question to answer since the word "construction" and the word "management" are both sources of considerable confusion in themselves. Webster defines the word "construction" as "the act of putting parts together to form a complete integrated object."[5] In industry practice "construction" is used in a variety of ways and scopes. "Construction" can be restricted solely to the building phase of a project - the implementation of the plans and specifications. "Construction" many times is used to describe the process of designing and building a project, since design is a prerequisite of putting work-in-place. "Construction" is even stretched to include the early planning stages of a project as far back as identification of the requirement for a facility. The end product of the process is a facility. The facility was produced by the act of building which followed the designer's intent. The designer's product was based upon satisfying a need. "Construction" is frequently applied to all these segments of the facility production process. Thus, the word "construction" can be the source of some confusion in itself.

Webster defines the word "management" as "the conducting or supervising of something especially the executive functions of planning, organizing, coordinating, controlling and supervising an industrial or business project or activity with responsibility for results," and "the judicious use of means to accomplish an end."[6] This definition coupled with one's experience validates that the term "management" can be a confusing term as well.

When the two words are combined to form the term "construction management" the confusion which surrounds the term is also multiplied. The foreman who supervises a crew of carpenters could consider himself a construction manager. After all, he directly supervises labor in applying material resources to construct an end product. The subcontractors who on

many projects physically do 70-80 percent of the work can consider themselves construction managers. In addition to being the organization responsible for putting the bulk of the work in place, the subcontractor is closest to the actual work itself. The subcontractor must plan his portion of the work, order and receive the material, ensure that his workforce is on site when required, and ensure that the work is in accordance with the plans and specifications. No one can deny that the subcontractor is a construction manager. The general contractor will be the first to say that he is a construction manager and that he always has been. The general contractor has the ultimate contractural responsibility to provide the facility in accordance with the plans and specifications. He manages the portions of work done by his own forces in the same manner as the subcontractor. He also coordinates, schedules, and directs the subcontractors. Management of the construction process is important to him, since he has usually agreed to build the facility for a fixed amount of money. Waste and mismanagement can produce significant losses to the general contractor. However, there are other organizations outside the ones that physically construct the facility that frequently lay claim to the term "construction management."

Architects and engineers (A-E) may claim that they perform construction management. Drawing the plans and writing the specifications determines the work which a contractor will have to perform, controls the materials which he will use, and many times even specifies the method in which they will be applied. The A-E also inspects the work and approves shop drawings and material submittals to ensure compliance with design intent.

The owners, particularly large, industrial corporations or some federal government agencies have sophisticated facilities engineering divisions which plan and program construction requirements for their parent organization. Although most design and construction is actually performed through contracts with A-E's and contractors, the in-house expertise of these organizations allows them to exercise tight control over the process of facility production. For example, the Naval Facilities Engineering Command (NAVFAC) performs this function for the U.S. Navy and in some cases for other services and agencies. In addition to maintaining and operating

world wide Navy shore facilities, NAVFAC also identifies and plans for facility requirements, develops projects to satisfy these requirements, assists decision-makers in determining the priority of projects, obtains funds to accomplish the projects, and designs and constructs the projects. Most projects of significant size are designed by private A-E and constructed by contractors, but NAVFAC closely monitors the design and construction. In some cases NAVFAC may perform design and/or construction In-House. In any case, there is little question as to why NAVFAC and other similar organizations perceive themselves as construction managers.

There are other organizations who exercise influence in the management of construction. Banks and lending institutions exercise control by perhaps limiting the size, scope and nature of projects the owner can undertake, and they often influence whether or not a contractor can even bid on a project. Bonding companies are keenly interested in the efficient management of a project to ensure their contractors remain solvent.

Safety organizations such as the Occupational Safety and Health Administration (OSHA) control the construction to the extent that certain safety features are provided for in the new facility and that safe construction practices are used. Insurance companies likewise are interested in the safe management of construction and they use inspection, investigation, and their rate structure to exert some control over the process. Testing firms and laboratories exercise control over construction by certifying that material specifications have been achieved. Even professional and industrial associations have a role in construction management.

The American Institute of Architects (AIA), American Society of Civil Engineers (ASCE), Consulting Engineers Council, National Society of Professional Engineers (NSPE), Associated General Contractors of America (AGC) and like organizations set standards of performance that their members are to abide by in the process of designing and constructing. Other organizations set the standards for materials. The American Society of Testing Materials (ASTM), American Concrete Institute (ACI), American Institute of Steel Construction (AISC), and other similar organizations influence the

construction process in this way. Therefore, depending on one's role(s) in the multi-faceted construction industry the perceptions of what the term "construction management" means can be very diverse. To maintain understanding throughout the rest of this thesis, the need for defining the term "construction management" becomes essential.

1.3 Construction Management Defined

The term "Construction Management" on a given project shall mean:

(1) The application of construction expertise to the design phase in the form of market analysis, estimating, cost alternative generation, constructability control, and contract packaging decisions

(2) The supervision, coordination and inspection of the multiple contractors and the provision of construction support items in the construction phase

(3) The responsibility for the scheduling and control of cost and time for the integrated process of design and construction, and

(4) The delivery of services in a professional manner

Further "construction management" as defined shall hereafter be referred to as "CM" to reduce the possibility of confusion with other roles in the construction process. This attempted definition of CM can now at least provide a boundary in which the further discussions of the CM approach can take place. A comprehensive discussion of CM is covered in Chapter 4.

1.4 CM - Its Origin

CM certainly did not evolve based on the brainstorm of some profit-hungry entrepreneur. It was not developed specifically to slash construction time, or specifically to combat inflationary forces. Its origin is rooted in a much deeper cause - that of owner dissatisfaction. Owners as the users of newly constructed facilities have become increasingly dissatisfied with the ways buildings are designed and constructed. John H. Newman of Tishman Realty and Construction Company, Inc., a large owner-builder, gave a fair appraisal of the attitude of many owners when he said, "Owners are tired of buildings that don't work as intended and don't get built on time or within the budget."[7] These owners as facility users may

be completely ignorant of the science of design and construction; however, common sense tells them something is lacking in the design and delivery of construction.

Generally speaking, it has been the lack of effective management that has created the disdain for the design and construction process. Years ago during the Industrial Revolution the manufacturing industry was faced with the problems of planning, designing, implementing, operating, controlling, and coordinating production processes. Then these production processes had to be integrated with the processes of marketing, selling and servicing the product. Without the coordination and control that the management process provides, the large industrial firms of today simply could not exist. The twentieth century has seen a rapid development in the art and science of management, due to the critical needs of industry. These critical needs are just as apparent in construction today as they were in the manufacturing industries decades ago. Construction has become a complex business - buildings and facilities are more complicated to construct; a multitude of building materials are available on the market; designs are more intricate; the construction product must be suitable to its environment; the cost of construction has skyrocketed; and the new construction worker is well paid, educated and quite independent.[8]

An official of the General Services Administration identified the problems which prompted owners to switch to the CM method more specifically as:

(1) increased cost of construction

(2) lower productivity of construction resources

(3) increased complexity of projects

(4) increased involvement of communities in environmental considerations

(5) rapidity of change

(6) general contractors high contingency cost included in his bid to offset the above conditions[9]

1.5 CM - The Functions

Contrary to the impression left by most periodical articles that CM firms perform all the management functions required on a construction project and do them well, the CM's responsibilities are quite specific, though they may vary from job to job. The CM system brings into the design phase construction-oriented inputs which are usually not included under the traditional system. Since construction contracts are awarded to numerous contractors rather than a general contractor under this system, the CM actually assumes most of his responsibilities during the construction phase. The difference is the relationship of the builder to the owner. While a general contractor's relationship is strictly "arms length," the CM-owner arrangement is intended to be professional, which should give the owner more control over his project. The CM works for a fee and in many cases bears no financial risk in the project, which should reduce the conflict of interests between the owner and CM. Some prefer to say, "He's on the owner's team."

To illustrate the scope of a CM's typical responsibilities, the following list of functions is provided. They will be discussed in detail in Chapter 4.

PREDESIGN

- Performs Construction Market Study

DESIGN PHASE

- Provides Construction Economy Inputs
- Performs All Estimating
- Provides Bid Packaging Recommendations
- Performs Design Reviews
- Makes Long Lead Material Procurement Recommendations

BID PHASE

- Assists in Potential Bidder Identification
- Serves as Bidder Information Source
- Advertises, Holds Bid Openings and Awards Contracts (optional)

CONSTRUCTION PHASE

Provides Temporary and Common Use Facilities

Directs, Schedules and Coordinates Contractors

Maintains Quality Control Program

Performs Initial Progress Payment Review

Initially Processes Change Order Requests

Provides Initial Shop Drawing Submittal Review

Maintains Project Safety Program

ALL PHASES

Produces and Updates Integrated Project Schedule

Maintains Project Management Information System

1.6 CM - The Benefits

The CM approach to construction procurement allows the overlap of the design and construction phases, which is sometimes called "fast-tracking." This allows the construction phase to be started when the working drawings and specifications are complete enough for a logical beginning, such as the site preparation and excavation. Thus, phased construction allows for timesaving. Since work is bid a short time before it is actually supposed to start, the bidders can reduce their contingencies because the uncertainty of labor and material cost fluctuations is reduced. Time and cost savings should also accrue from the CM's efforts in the design phase to make the project construction efficient. The quality of the project should be ensured since the CM has no financial interest in "cutting corners," and his professional reputation and his ability to get more jobs depends on his ability to deliver quality projects on schedule and within the budget. Although the previous description may sound like an endorsement of CM, it must be recognized that CM is different in many respects from a traditional technique of procuring construction where design, bid, and construction are basically treated as three separate sequential phases. Replacing a tried and true system, even though it may not be the most efficient, with a new method must be approached with careful and thoughtful analysis. This paper is intended to serve as a beginning in such an analysis.

1.7 Why Study CM?

Some people may question the need for studying the CM approach. Perhaps some have semantical difficulties with the words "construction management" as discussed earlier in this chapter. Perhaps some see any break from traditional modes as an indicator of subsequent organizational upheaval. However, any system which has the potential of being more responsive to an owner's or facility user's needs is worthy of examination no matter what that system may be or may claim to be.

Peter Drucker says, "Managers must learn to build and manage an innovative organization. They must learn to build and manage a human group that is capable of anticipating the new, capable of converting its vision into technology, products, processes and services - and willing and able to accept the new."[10]

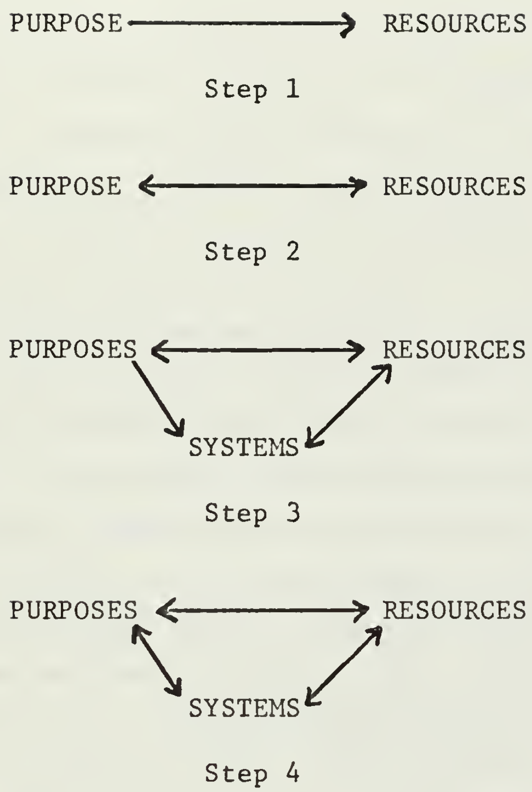
Therefore, two reasons are offered as to why this topic should be of specific interest to the Navy. The first is a defensive motive to protect one's self and to remain flexible to a changing environment in order to permit continued procurement of construction in an effective manner. One authority has predicted that 50 percent of all building construction will be done on a design-build concept within five years.[11] The second is an offensive motive designed to exploit potential gains which could make the facilities production more effective for the Navy.

1.8 Management Analysis

If the CM method is to be adequately explored for use by the Navy, then a systematic approach to management analysis must be used. It has been written that we should "beware of technique advocates."[12] One should consider the entire system in which we function before committing an organization to a new "idea." One aspect of a system may be optimized to the detriment of the other parts and even the system as a whole. Thus, for this study a systematic management approach for analysis has been selected.

The systems approach initially gives the "big picture" from which specifics of the overall system can be focused on as required. In a complex setting such as the Navy and its facilities arm, NAVFAC, new techniques such as CM must be evaluated in a systems context in order to be properly assessed. Systems approaches are becoming more and more accepted as an evaluation tool, and this is evident with the increasing concern about things such as life cycle costs, environmental impacts, and energy efficiency. De Neufville and Stafford provide one of the simplest descriptions of a systematic analysis by identifying the five basic steps as: (1) definition of objectives, (2) formulation of measures of effectiveness, (3) generation of alternatives, (4) evaluation of the alternatives and (5) selection. The reader will note that these steps emerge in the model used to outline the logic of this thesis presented later in this chapter.[13]

Management analysis, in addition to being systems oriented, should also evaluate alternative operating systems and subsystems with respect to an organization's ultimate purpose and the resources that are available to implement the system. Gerald Nadler developed the model shown in Fig. 1.1 to illustrate this notion. He states that the first requirement of an organization is a purpose and the second is resources required to achieve the purpose (Step 1). The presence of certain resources or the non-availability of others can affect the stated purpose or generate additional ones. Thus, there is an interaction between purposes and resources (Step 2). In order for resources to be employed to satisfy the purposes, systems must be developed (Step 3). Systems also have a feedback effect on purposes and resources. A change in a management system can require use of different resources and can even eliminate organizational purposes (Step 4).[14] The key concept here is that purposes, resources and systems all interrelate with each other, and this interaction is extremely important when considering the application of a system like CM for use in the Navy procurement of contract construction.



Source: Nadler G., Work

Fig. 1.1. Nadler's PRS Model.

Another perceptive notion that can be very useful and complimentary to a systems analysis is one promulgated by Russell Ackoff. He distinguishes between solutions which are of an optimizing character and those which are of an "adaptivizing" character.[15] The quantitative world of operations research has introduced the widespread notion of optimization. Ackoff maintains that too often the goal of planning is optimization - how can the existing system be made more efficient? He maintains that the focus of planning should be "adaptivization." This is a broader approach that seeks to consider the total system and develop alternatives which will make the system more effective rather than just more efficient. Where optimization may try to develop a more efficient stacking arrangement for pallets in a warehouse, adaptivization may determine that the warehouse is not needed at all by making some other changes in a plant's operation.[16] The foregoing notions can be viewed as purely theoretical; however, this writer believes that analyses of problem areas, existing systems, and alternative proposals can be much more comprehensive when evaluated in adaptive systematic contexts, even if only used in a quantitative sense. None of these "academic" notions suggest the exclusion of "real world" problems that could impact on a proposed alternative. In fact, the way they are postulated seems to encourage consideration of all possible impacts. When a decision-maker adopts an adaptive-systematic frame of mind and momentarily removes himself from the arena of the day's business to stand back and view his organization and proposed alternatives as they affect the "big picture," he becomes more perceptive and more effective as well.

1.9 Purpose and Scope of Thesis

The purpose of this thesis is the examination of the suitability and potential benefits of using CM for the procurement of NAVFAC contract construction. Can CM be of some use to the Navy? Can it help the Navy to accomplish its missions, goals and objectives more effectively? Can CM achieve more productivity out of each tax dollar NAVFAC has allocated for construction? The scope of the study shall be of an exploratory nature, for this thesis is not designed to present a comprehensive action plan for

implementation of CM within NAVFAC. But hopefully, it will serve to answer general questions in the readers' minds about the CM method, the NAVFAC construction system, and the possible impact of the use of CM by NAVFAC. The exploratory character of the study may also open up topics for future study.

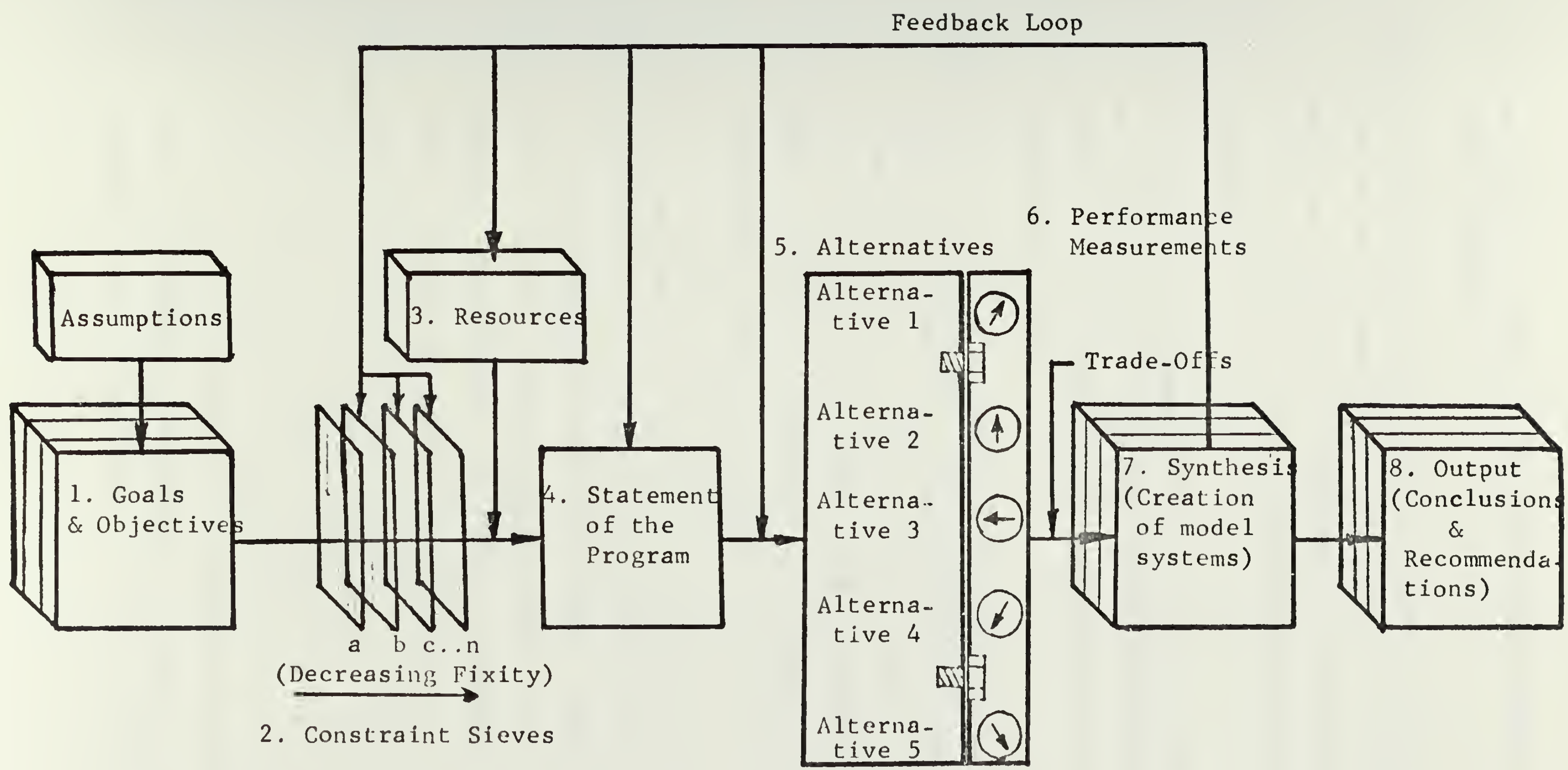
1.10 Methodology of Thesis

A model of the methodology used in this thesis has been adapted from a management systems model developed by Dr. Eugene Konecci of the Graduate School of Business of The University of Texas at Austin. The model is depicted in Fig. 1.2 and the elements of the model are numbered to correspond with the following explanation:

(1) First the goals and objectives of the system must be stated. In the case of the Navy the beginning point would be the mission of the Navy, followed by more specific goals, particularly relating to shore facility requirements and construction of new facilities. Certain assumptions may have to be added to begin the process of translation of these goals into a program.

(2) The translation of goals into a program must first be "strained through the constraint sieves." The various sieves could represent different levels of constraints placed upon the development of a program. For example, sieve A could represent congressional constraints; sieve B, Department of Defense constraints; and on down through NAVFAC policy constraints. The sieve notion does not necessarily have to follow organizational lines. For example, one sieve could be used to indicate behavioral or public opinion constraints. The sieve idea can be viewed in the context that sieves to the left are more fixed than sieves to the right. To illustrate this point, it is logical to assume that changing a law, a Congressional constraint, would be significantly more difficult than changing NAVFAC policy.

(3) The next input to the system is the available resources. Resources could include talents, organizational structures, funds,



Adapted from model by: Kleberg Professor, Dr. Eugene Konecci
Graduate School of Business, The University of Texas at Austin

Fig. 1.2. Thesis Model.

information systems or any item which allows goals to be translated into a program.

(4) The next logical step is the statement of the program, which is the plan to be implemented to bring about realization of the stated goals and objectives. This will be the statement of NAVFAC's existing program for the planning, programming and acquisition of facilities.

(5) Following the statement of the existing program, alternatives will be introduced and discussed. These include the forms and features of CM that could conceivably be applied to the Navy's construction procurement system.

(6) The next step in the model is the performance measurement phase. This phase measures the effectiveness of the various techniques of construction procurement, which include the existing system as well as the alternatives. The evaluation will attempt to stress functional strengths and weaknesses of systems and techniques. This will be augmented by results from actual projects to the maximum extent possible.

(7) The subsequent setp will be a synthesis of the evaluated alternatives into hypothetical models for use in procurement of contract construction by the Navy. Trade-offs that must be made to arrive at these various models will be discussed. The impacts, consequences, and required changes which will occur as a result of implementation of these models will be predicted. The feedback loop represents the effect of using a model or the various components of the system. For example, the use of a particular model system could require changes in various constraints to allow it to be used or to be effective. It could even impact on the resource structure and on the way the existing program is stated. Although this thesis will make one cycle within this system, the initial feedback will be predicted.

(8) The final step is the output statement, which will present the conclusions and recommendations resulting from this study. The recommendations will provide follow-up actions which can be taken.

To apply the model to the actual presentation of material in this thesis, the following should serve as a guide. The discussion of goals and objectives, constraints and resources is contained in Chapter 2 while the existing program statement is presented in Chapter 3. The discussion of the alternate CM systems and techniques is discussed in Chapter 4. The evaluation phase is covered in Chapters 5 and 6. Chapter 5 is an evaluation of the existing Navy system and Chapter 6 evaluates the alternative CM systems. Chapter 7 is the presentation of hypothetical construction procurement systems for use by the Navy and a discussion of what feedback these systems might return to the earlier stages of the model. Finally, Chapter 8 will be the output or the conclusions and recommendations for further study and action.

It should be noted that this thesis represents only one pass through the model. To properly treat a topic such as CM, numerous cycles must be made through the model with each pass analyzing more specific elements of the system and more quantitatively oriented data. This paper should help in determining whether subsequent passes through the model are necessary at all.

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CHAPTER 2

THE OBJECTIVES AND ENVIRONMENT OF NAVY CONSTRUCTION PROCUREMENT

2.1 General

This chapter will seek to establish (1) the objectives for which Navy contract construction is performed, and (2) the environment which constrains and provides resources to the planning, designing, and building of new facilities.

2.2 Fundamental Objectives of the System

To begin any systematic analysis one must have a clear idea of what the basic goals and objectives are of the organization in which the study is being made. The fundamental objectives of the entire organization need to be considered, even though on the surface this may even seem extremely elementary. At best, it can serve to eliminate choosing alternatives which actually impede an organization from realizing its goals.

In the context of construction procurement by the U.S. Navy, there are three levels where basic purposes are defined. Hopefully, the Navy construction program is seeking to support these objectives. The three key levels where the purposes of the defense structure and facilities support emerge are:

(1) the Department of Defense (DOD)

(2) the U.S. Navy

(3) the Naval Facilities Engineering Command (NAVFAC)

A presentation of the defense hierarchy structure and how NAVFAC's construction program fits into accomplishing the goals of national security is included for those unfamiliar with the subject. Assuming that the knowledge of the public may range from total ignorance of the

construction function within the Navy to the intimate knowledge of it as possessed by the Civil Engineer Corps (CEC) officers and NAVFAC employees, meaningful conclusions could not be drawn from a presentation of alternatives without knowing the goals of the defense structure and how the Navy's construction system seeks to fulfill these goals.

The Department of Defense maintains and employs armed forces to

(1) Support and defend the Constitution of the United States against all enemies, foreign and domestic;

(2) Ensure, by timely and effective military action, the security of the United States, its possessions, and areas vital to its interest;

(3) Uphold and advance the national policies and interests of the United States; and

(4) Safeguard the internal security of the United States.[1]

The fundamental objectives of the Department of the Navy, within the Department of Defense, are

(a) To organize, train, equip, prepare, and maintain the readiness of Navy and Marine Corps forces for the performance of military missions as directed by the President or the Secretary of Defense, and

(b) To support Navy and Marine Corps forces, including the support of such forces and or forces of other military departments, as directed by the Secretary of Defense, which are assigned to unified or specified commands. Support, as here used, includes administrative, personnel, material and fiscal support, and technological support through research and development.[2]

The purpose of the Naval Facilities Engineering Command is to provide support to the operating forces of the Navy, the Marine Corps, other components of the Naval Material Command and other offices and organizations in regard to shore facilities and related engineering, material and equipment.[3]

Though these missions do not give any information on how things operate, they do give a statement of purpose - a statement of what the construction program is trying to assist. The next step then is to examine the environment in which the construction program must operate.

2.3 Environment

The environment for Navy military construction includes many segments such as:

(1) the military environment

(2) the public environment

(3) NAVFAC's organizational structure

(4) the construction industry

2.3.1 Department of Defense/U.S. Navy Environment

2.3.1.1 Organization

The military environment here means the Department of Defense and the Department of the Navy. Figure 2.1 shows the organization of DOD and how the Navy fits into the national defense structure. The Department of the Navy is located on the readiness and support side of the organization and the arrows flowing to the operational side indicate to what element of DOD the support is directed. Figure 2.2 shows the basic organization of the Navy, with NAVFAC located under the Chief of Naval Material as one of the principle systems commands. NAVFAC, through its headquarters and field activities, provides facilities support to the operating forces of the Navy and Marine Corps.

NAVFAC functions much as the facilities arm of a large company would. The big difference, of course, is in the nature of the requirements. While a company's investment in construction is in expectation of eventual financial returns, the Navy's investment in facilities is for different reasons. The Navy expects a return, but is expects it to be in the form of enhancing of the naval service's ability to accomplish its mission. This tends to be a very difficult area to quantify, though it has

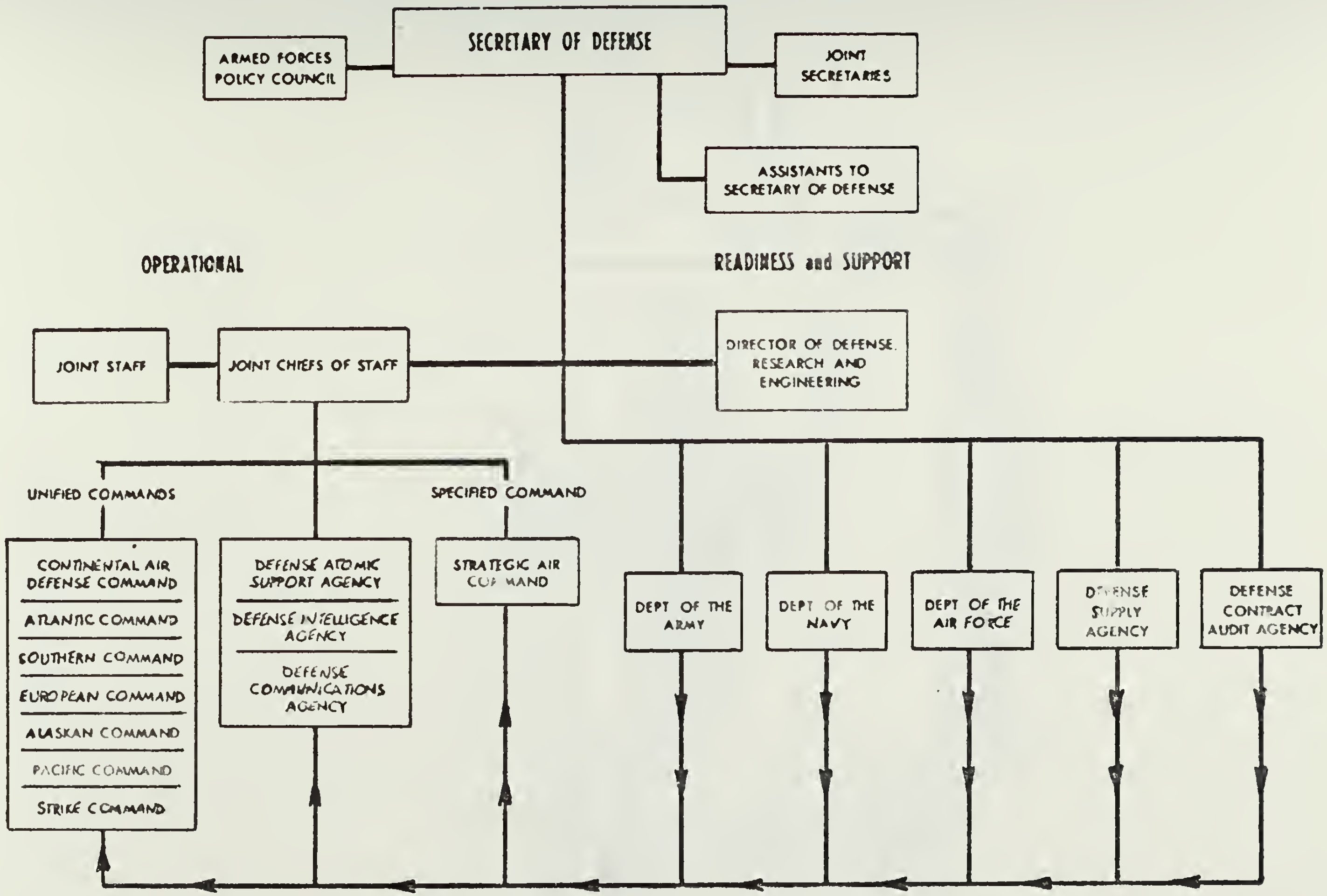

Fig. 2.1. Department of Defense.

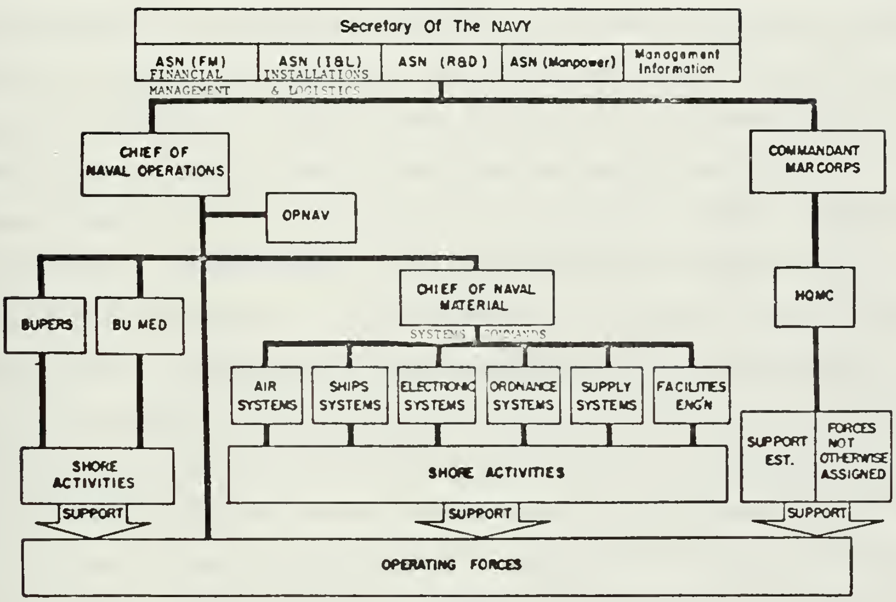

Fig. 2.2 Department of the Navy.

been attempted. James Schlesinger, former Secretary of Defense, wrote in 1963 that a strict quantitative analysis of the submarine based Polaris IRBM system to the land based Minuteman system would show the Minuteman as much more cost efficient than the Polaris. The procurement costs of the Polaris missiles are higher; a submarine is an expensive launching platform requiring two large crews, port facilities, two months a year overhaul time, and time to move on and off station. The Polaris is reportedly less destructive and less accurate than Minuteman. But what about the invulnerability of the Polaris, and the resultant diversion of Soviet military resources into antisubmarine warfare investments? Emphasis on easily quantifiable figures can distort the picture. "Simple dedication to efficiency in the spirit of operations research might easily lead to the wrong decision."[4] Thus, the simple quantitative oriented present value models of the enlightened business executive are insufficient. Major military decisions must then be more qualitative in nature. Theoretically, the Navy is more interested in what a new weapons system, or a new drydock, or a new training facility will do for them in terms of better accomplishing their mission without regard to cost. However, there is much concern about cost in military decision-making for this is due to the influence of the public environment. It is imperative, though, that decision makers view alternatives first in terms of their impact on mission accomplishment. Over quantification can lead to systems which appear to be cost effective, but which, in fact, may be mission ineffective.

2.3.1.2 Requirements

The nature of the requirements of the military are such that great premiums are placed on responsiveness and flexibility. This responsive stance extends into areas of construction support as well. The Navy Seabees' primary function is to provide advanced base construction for military operations at any point on the globe. However, military reactions to events in the Western Pacific could very likely cause a significant increase in activity at a Navy ammunition depot in Oklahoma. That event could also cause the transfer of several fighter squadrons from the East

Coast to the West Coast. Such sudden shifts or changes in activity could strongly affect facility needs in a short time frame. If new construction is required to fill these stateside needs, then these requirements will most likely be satisfied through contract construction. The quick readjustment of the posture of the armed forces can impose a very short planning horizon on the delivery of construction, creating a challenge for a process which is normally quite deliberate.

The rapidly changing events in the military environment may not only be in response to worldwide military and political actions, but they could also be the result of technology breakthroughs such as the introduction of a new type of aircraft, a new missile or a new waterborne surface craft for which existing support facilities may not be adequate. Other events such as an energy crisis, new environmental standards, and highly political decisions (i.e., base closures and realignments), can affect facility requirements in a sudden fashion. As a result, defense construction agents, like NAVFAC, are expected to react in an expeditious manner to see that the newly created requirements are satisfied.

2.3.2 Public Environment

Unlimited resources, however, are not available to dedicate to a "super responsive, mission-oriented utopia." The public environment acts as a continuing constraint on the military establishment through civilian control as guaranteed by the Constitution and Congress. The Congress, through its powers, controls the activities of the armed services. Not only are specific actions and practices of the military controlled to some extent by the Congress, but also the allocation of financial resources by the legislative branch is a strong constraint on defense programs and activities. The Congress authorizes and appropriates funds for the annual military construction programs designating which projects the services can build within the fiscal year. The most significant document in controlling the procurement methods of contract construction is the Armed Services Procurement Regulation (ASPR). This manual, published and continually updated by DOD, is the written intent of governmental policy with respect to procurement by the military services.

2.3.2.1 Congress

The manner in which the Congress conducts its business has a profound effect on military construction (MILCON) programs. The annual budget approval process that Congress utilizes has a significant effect on the manner and speed in which construction can be procured.

2.3.2.1.1 Government Accounting and the Congress

The accounting system of the government affects decisions for military construction. The federal system is based on a cash budget rather than an accrual system which is the primary system of business. Expenses are not shown until cash payments are actually made. Award of a construction contract may obligate funds for use on a particular project, but no costs are expensed until a payment for the work is made. Large projects which may service the government for 50 years are not allowed to be expensed over the life of the facility, but rather are completely expensed by the end of the project. This type of system does not give an accurate picture of the assets held by the U.S. government, but it may be congruent with the goals of many Congressmen as they view government spending. Many of these statesmen view government spending programs, of which construction is a primary one, as a means to bolster (1) the economy of their regional constituencies and (2) the national economy as a whole. Thus, the effect of government spending is not felt by the economy until payments are made for services rendered. Finally, the nature of the government accounting system may seem inefficient from the manager's point of view, but it suits the requirements of the Congress.

2.3.2.1.2 Budget Control and the Congress

The MILCON budget is one of the most closely scrutinized budgets the Congress reviews before approval. The goals of the Congressmen who review the MILCON program may be very diverse, but there does seem to be some common concerns and areas of emphasis that have significant influence on the way funds are authorized and appropriated. The questions contained in Appendix A were posed in a letter to Senator John Tower (R-Texas), and his letter reply is shown as Appendix B. Gil H. Woerner of NAVFAC, who is directly involved in the preparation for and in the proceedings of

Congressional subcommittee hearings on the MILCON budget requests, was interviewed by the writer regarding the areas of concern to the Congressmen.[5] The interview and the letter both indicated that (1) validity of construction requirements, and (2) cost are the prime concerns of the law makers. The manner in which projects are implemented, their responsiveness in meeting the need, and the progress of construction are of little concern to the legislators, other than in the case of severe cost problems or highly unusual circumstances. The government overhead cost in connection with construction has also been the topic of some concern to the various subcommittees.[6] This is understandable since it is actually part of the total construction cost.

In deciding at what magnitude to finance the proposed MILCON program, the Congress does view the success with which the preceding year's program has been obligated. Obligation here means that the construction contract for a project has been awarded. This has no bearing on the physical progress of the job or the amount of payments made, but it is some measure that the project is at least in the construction phase. As Mr. Woerner explained, Congress tends to underfund the proposed MILCON budget in proportion to the size of unobligated portions of last year's appropriation.[7] Therefore, there seems to be some correlation between success in obligating one year's budget with the success in getting a higher percentage of next year's budget appropriated.

2.3.2.2 Armed Services Procurement Regulation (ASPR)

The ASPR is the document that implemented the Armed Services Procurement Act of 1948. A letter from the President to the Secretary of Defense on 16 February 1948, stated that this act was the basic policy of the Government with respect to military procurement and even though the services were granted some latitude in their procurement methods under the Act, the basic need remained to assure favorable price and adequate service to the Government. This was to be primarily achieved through formal advertising with a fair share of all procurement to be awarded to small business concerns.[8] The ASPR clearly reflects this intent. In the General Provision section of the document three objectives are stated very clearly:

(1) All procurements, whether by formal advertising or by negotiation, shall be made on a competitive basis to the maximum practical extent.[9]

(2) Purchases and contracts for supplies and services shall be made by formal advertising in all cases in which the use of such method is practical and feasible under the existing conditions and circumstances.[10]

(3) It is the policy of DOD to place a fair proportion of its total purchases and contracts for supplies, research and development, and service (including, but not limited to contracts for maintenance, repair and construction) with small business concerns.[11]

2.3.2.2.1 Formal Advertising

The Armed Services Procurement Regulation outlines the requirements for the entire bidding process-solicitation, submission and award. The award must be made to the lowest responsible bidder whose bid is responsive to the Invitation for Bids.[12]

2.3.2.2.2 Negotiation

ASPR is very clear in defining when negotiation is permitted and who has the authority to authorize it. In regard to construction negotiation, this is only permitted for:

(1) National Emergency declared by the President or Congress

(2) Public Exigency such as fire, flood, explosion, other disasters, of a structure and/or its contents which are in immediate danger.

(3) Small purchases less than $2,000 for construction.

(4) Personal or professional services

(5) Purchases outside the U.S.

(6) Supplies or services for which it is impractical to secure competition through formal advertising

(7) Experimental, developmental or research work

(8) Classified purchases

(9) Negotiation after advertising fails.[13]

Contracting officers are further constrained in that determinations and findings must be made to justify entering into negotiated contracts and to justify the type of contract being used. The hierarchical level at which determinations to negotiate can be made are in some cases very high. For example, only at the Secretary of Defense level can reasons (7), (8), and (9) above be used to justify negotiations.

2.3.2.2.3 Small Business

The Armed Services Procurement Regulation requires that all proposed procurements for construction between $2,500 and $500,000 be automatically set aside for small business concerns to bid. In general construction, a small business contractor is defined as one whose average annual receipts for the last three years do not exceed $7.5 million. For subcontractors, different amounts are specified depending on the type of work done, but the range for average annual receipts is $1 million to $2 million.[14]

2.3.2.2.4 Maximizing Competition

The ASPR seeks to maximize competition throughout all the levels of contractual relationships that may result from the basic procurement contract.

> Plans, drawings and specifications or purchase descriptions shall state only the actual minimum needs of the Government and describe the supplies and services in a manner which will encourage maximum competition and eliminate insofar as possible, any features which might limit acceptable offers to one supplier's product, or to the products of relatively few suppliers.[15]

Proprietary specifications are not allowed, either directly or indirectly.

Thus, the public environment imposes the reality of cost and the mechanisms necessary to protect public funds as constraints on the military's plans for mission accomplishment.

2.3.3 Naval Facilities Engineering Command Organizational Environment

The organizational structure and operating procedures of NAVFAC can also be considered an environmental factor in the procurement of

construction by the Navy. Although NAVFAC provides construction services for the U.S. Navy, this is only one of its functions. Since the facilities planning and contract procurement process will later be discussed in detail, this section will give an overview of the functions that NAVFAC performs.

NAVFAC is charged with:

(1) Support and training of the Naval Construction Force (SEABEES)

(2) Designing and Constructing all shore facilities and deep ocean structures for the Department of the Navy and other agencies when assigned

(3) Planning for all shore facilities requirements

(4) Maintenance and operation of the Navy's shore establishment

(5) Management of the Navy's real property

(6) Research and development work on problems related to NAVFAC's functional areas

(7) Maintaining readiness for contingency actions, limited or general war for mobilizations areas that involve NAVFAC functional areas.

(8) Assure the readiness and capability of Civil Engineer Corps officers and Seabees in the Naval Reserve in the event of mobilization.[16]

The functions of NAVFAC involve more than just new construction for the Navy. The organizational relationship that exists with other parts of the Navy for accomplishing these functions adds even more complexity to the situation. Examples of these organizational complexities are :

(1) Even though NAVFAC is concerned with maintenance and operation of Naval shore activities, the funds for this function are allocated by the major command who is the primary user of the base. Thus, NAVFAC must provide guidance for management of the Public Works Department, technical assistance, and assistance to the major command in determining the funding levels required to maintain and operate the base.

(2) NAVFAC is primarily a Civil Engineer Corps (CEC) command, but it does not have complete control over CEC officers. The Bureau of Naval Personnel assigns them, the Navy Education and Training

> Command educates them, and the majority work in activities whose chain of command does not include NAVFAC. However, the Commander of NAVFAC is the Chief of Civil Engineers, so NAVFAC is looked to for overall CEC manpower planning and CEC selection criteria. On the other hand, all CEC officers feel that NAVFAC should look out for Navy wide CEC interests.

NAVFAC is caught up in literally hundreds of these organizational relationships and interdependencies, with some formally drawn and many which are informal.

In summary, two points should be clear before looking at the formal organization of NAVFAC and its subordinate commands.

(1) NAVFAC performs more functions than just design and construction

(2) NAVFAC does not exist in a vacuum, but in the complex organizational framework of the Navy within which many inter and intra-relationships exist.

Figure 2.3 shows the organization of NAVFAC and its field activities. In addition to Engineering Field Divisions (EFD), which are primarily of interest here, there are nine Public Works Centers which provide common public works support to all commands in large Naval complexes and two Construction Battalion Centers which are home bases and support sites for Naval Construction Forces (SEABEES).

The headquarters organization for NAVFAC is shown in Fig. 2.4. In examining the organization, one can see that it is designed to cover the functions previously mentioned in this section. The Deputy Commanders for Facilities Acquisition (09A) and Planning (09P) are primarily concerned with meeting facility needs by construction. The Commander of NAVFAC is designated as the Contracting Officer for construction and other types of contracts that affect shore facilities. NAVFAC realizes that efficient implementation of the MILCON program and other construction programs cannot be directly managed from Washington. Thus, NAVFAC operates largely on a decentralized basis, with the Commander delegating most of his contractual authority to the Commanders of the EFD's and EFD's being charged with the responsibility for actually developing construction requirements and executing the MILCON program. NAVFAC's role becomes one of:

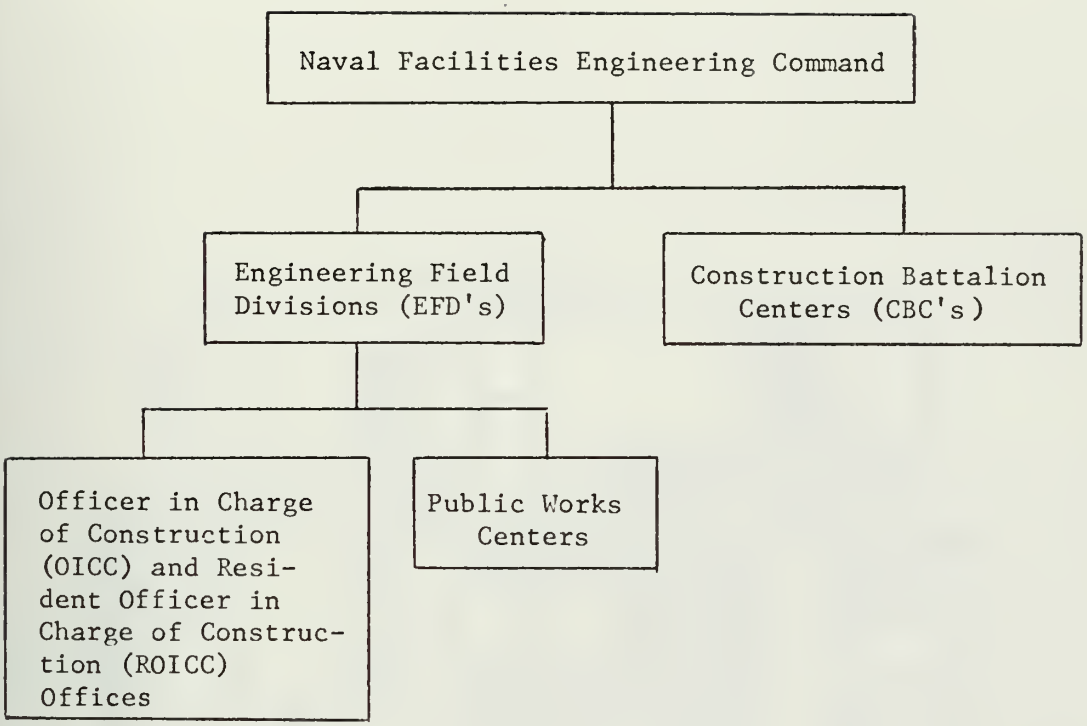

Fig. 2.3. Organization of NAVFAC and Its Field Organizations.

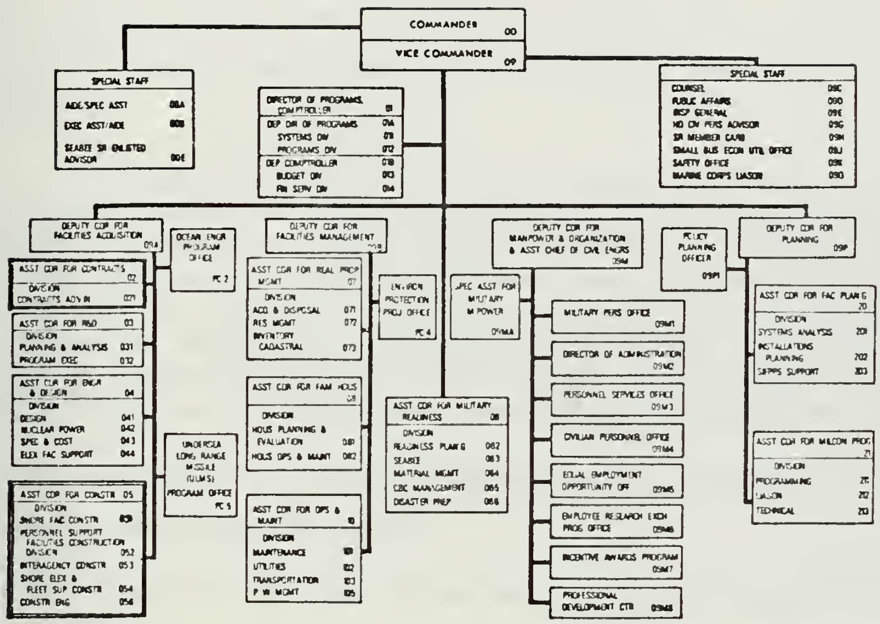

Fig. 2.4. Naval Facilities Engineering Command
Headquarters Organization.

(1) Basic policy formation

(2) Liason with major naval commands for which NAVFAC provides services, as well as with other DOD and federal government activities.

(3) Management on an exception basis of problems experienced by field activities.[17]

The Engineering Field Divisions are the regional arms of NAVFAC. There are six EFD's and they work closely with all the Naval shore activities in their geographic region on facilities matters. An organization chart for a typical EFD is shown in Fig. 2.5. In fact, their mission sounds much like the functions of NAVFAC that were listed previously:

> To accomplish the planning, design and construction of public works, public utilities and special facilities including acquiring and disposing of real estate of the Navy and other Federal agencies and offices; to direct and administer the operation and maintenance of family housing; to assist activities in the application of the programs which are assigned to the NAVFAC for technical or management direction; and to perform such other functions as may be directly by the Commander, Naval Facilities Engineering Command.[18]

In the realm of planning, design and construction, the EFD's are the level in the hierarchy where:

(1) Detailed work is done in assisting shore activities in developing planning

(2) Designs for major new construction are accomplished either in-house or with private A-E, and

(3) Construction at shore activities is monitored.

These functions are handled primarily by the Facilities Acquisition Department (09A) and the Facilities Planning Department (09P).

In order for EFD's to effectively operate on this decentralized basis, the Commander of NAVFAC has delegated most of his contracting authority to the Commanders of the EFD's. In using their contracting authority to award and administer contracts, these Commanders are referred to as Officers in Charge of Construction (OICC). The Commanders of the EFD's delegate the authority for smaller contracts to certain CEC Officers

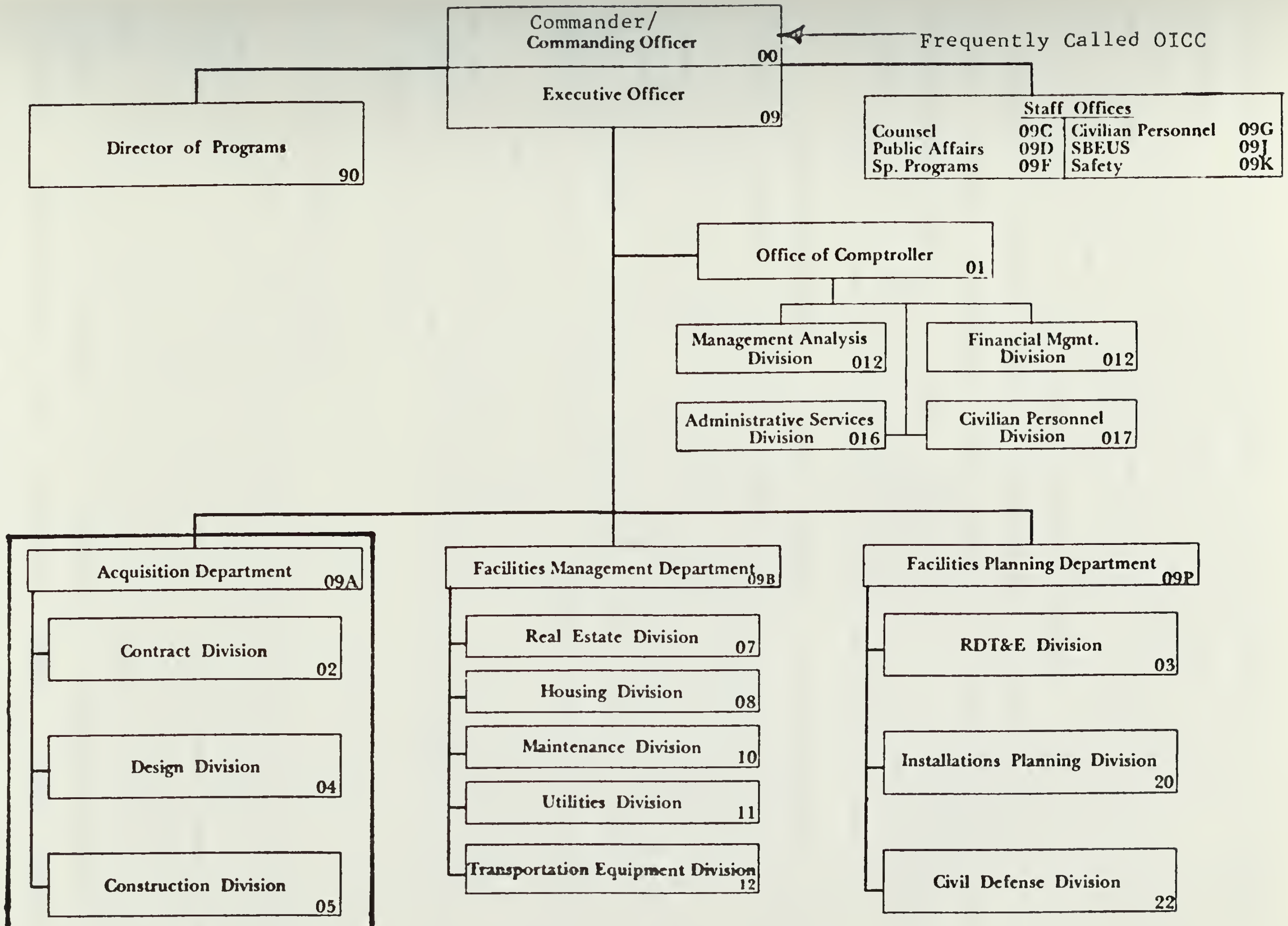

Fig. 2.5. Engineering Field Division Organization.

at Naval shore activities, so these officers become OICC's for limited scope work. Two EFD's, Pacific Division and Atlantic Division, are so large in geographic area and magnitude of workload is such that each one has further delegated its design, construction and contracting functions for certain locations to major OICC's. There are also two Officers in Charge of Construction who report directly to NAVFAC. They were formed to complete the specific tasks of building the support site for the Trident Submarine in Washington State and the Uniformed Services Medical University in Bethesda, Maryland. The organization of the OICC's is similar to an EFD's 09A or Facilities Acquisition Department - its three basic elements are design, contracts and construction divisions.

Each EFD and major OICC have numerous field organizations that are headed by a Resident Officer in Charge of Construction (ROICC) to administer contracts during the construction phase. These ROICC offices are located at most major Naval facilities, and the size and extent of each ROICC organization varies greatly with the volume and nature of the construction being undertaken. An example organization chart is shown in Fig. 2.6. The detailed functions of the ROICC will be explained later in this chapter.

NAVFAC's multifunctional organization has an environmental effect on the task of procuring contract construction. This multifunctional purpose should not be ignored in determining the most effective system for obtaining new facilities.

2.3.4 Construction Industry

The final segment which strongly influences the facility procurement process is the construction industry itself. The strength of national defense of the U.S. is largely a function of its industrial capabilities and capacities. Construction for defense purposes is no exception. The bulk of military construction is procured by contracts with the private sector, so that the application of the resources of the construction industry to defense projects has a significant impact on their outcome.

The industry is also extremely important to the economic condition of our country, and likewise it is quite sensitive to the economic state of the nation at any given time. The magnitude of the industry is enormous.

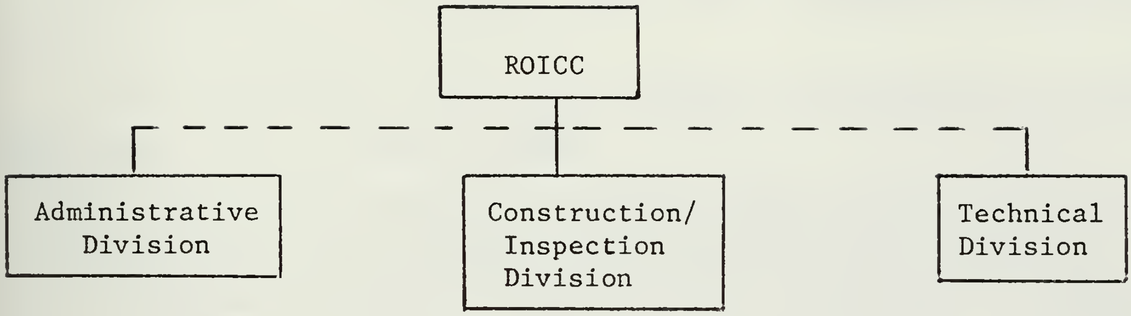

Fig. 2.6. U.S. Navy Resident Officer in Charge of Construction.

(1) 14 percent of the Gross National Product is accounted for by construction.

(2) 3,500,000 employees are directly involved in construction

(3) 16 percent of the nation's labor force is involved in construction related industries.[19]

The construction industry has also been characterized as a backward industry that is poorly managed.

> Construction contractors, generally speaking, have been slow in applying proven management methods to the conduct of their businesses. Specialists have characterized management in the construction industry as being 'weak,' 'inefficient,' 'nebulous,' 'backward,' and 'slow to react to changing condition.' This does not mean to say that all construction companies are poorly managed. On the contrary, some of America's best-managed businesses are construction firms, and it may be noted with satisfaction that the list of profitable construction companies is a long one. Nevertheless, in the overall picture, the construction industry is at or near the top in the annual rate of business failures and resulting liabilities.[20]

There are many reasons to dispute the claims of poor management by contractors.

(1) Construction projects are unique in character and do not lend themselves to standardization.

(2) Construction operations involve many skills and are largely nonrepetitive in nature.

(3) Projects are constructed under environmental conditions of weather, location, transportation and labor that are more or less beyond the contractor's control.

(4) The construction business is a volatile one, with many cyclical ups and downs.[21]

These superficial reasons do not make the results any easier to accept, however. Manufacturing productivity increased 25 times faster than construction productivity in the period 1900 - 1952, and there is no reason to believe that this trend has not continued.[22] From 1969 to 1973 40 percent of all business failures were in construction. This is three times the national average. Dun and Bradstreet indicated that 85 percent of these construction failures were due to poor management.[23]

Experts in industry, government and education are trying to help reverse the poor performance of the industry and in the process they are exploding some of the myths that innovative management methods and techniques originally used in manufacturing are not applicable to construction.

2.3.4.1 Contractors

For more insight into the construction industry one needs to know the nature of the participants in the process and their relationships. Contractors, for example, are mostly small firms. In 1970 there were 875,000 contractors in the U.S. Seventy-five percent of these employed an average of eight employees or less.[24] Seldom can one of even the very largest construction firms garner over 1 percent of the nation's construction volume.[25] There is no General Motors of the construction industry. Contractors tend to specialize and organize themselves along functional lines. It is not uncommon for a general contractor to perform only 15 percent to 20 percent of a job he has contracted for with his own directly hired personnel.[26] The rest of the work is subcontracted to specialty contractors. Electrical, mechanical, sheet metal, steel erection, concrete, elevator, and masonry subcontractors are examples of specialty contractors commonly found in most vertical construction projects, and collectively they do the bulk of the actual work. The general contractor has in effect, become a broker who contracts for the entire job under the traditional lump-sum contract approach, and he then turns around and subcontracts with specialty contractors for most of the project. The general contractor's function has become one of scheduling, coordinating, and controling subcontractors in addition to supervising the work of his own forces. Thus, the make-up of constructing organizations along functional lines has helped to promote smallness. The divisibility of resources into such small units could partially account for the slow pace of productivity gains. The meager size and technical orientation of firms has prevented them from investing in management improvements. National contractor associations have also failed to fill effectively this void and they still exist as loosely knit organizations that are interested mostly in lobbying efforts.

The lack of managerial initiative by construction contractors is substantiated by the presence of clauses in federal government contracts which require builders to use management tools such as CPM (Critical Path Method) schedules and to institute formal quality control programs.

2.3.4.2 Organized Labor

The nature of labor and particularly organized labor has a significant impact on the industry, since construction is a labor intensive business. The structure of organized labor with its 19 different construction trade unions complements the specialty structure of the contractor previously discussed. Contractors need flexibility to expand and contract their labor supply rapidly, and to move great distances from job to job. The unions provide a stabilizing function to the industry by

(1) Enforcing standards of work and compensation

(2) Conducting training programs

(3) Referring skilled specialists to work at the contractor's request.[27]

Bargaining and the resulting agreements are primarily local functions. The nation's 10,000 union locals do most of their own negotiating with local contractors associations, since the unions tend to be better organized than the contractors. Local agreements for a particular trade are generally not coordinated with other agreements in the same geographic area, and this results in a variety of expiration dates and work rules. These staggered expiration dates may result in a succession of strikes that "cripple" the progress of construction in a certain locality.[28] National unions and contractor associations play only limited roles in the bargaining process. National unions do not become involved until they are requested to approve a strike. National contractor associations have no power to intervene in local disputes and are too poorly staffed to do so.[29] In many cases national contractor associations and national union representatives reach agreements on issues menacing the "union" construction industry, such as regressive work practices that promote gains by open shop contractors. However, these "far sighted" changes are very difficult to incorporate into local agreements due to the limited powers of the national organizations.[30]

Labor's impact on construction is also a function of the nation's economic condition. When the economy is booming, construction usually is too; and labor is in short supply. In order to prevent successive work stoppages, contractors consent to wage demands more readily. During a strike union workers in one local's area can frequently work in a neighboring local's territory, so strikes frequently have less impact on the workers than on the employers. Locals become quite militant and seek to maximize wage gains and employment by sustaining regressive work practices. Since the market price of labor is fixed and every "union" contractor knows the unit cost of the other contractor's labor is the same, a contractor can easily pass the cost of wage settlements onto owners in later contracts without losing any competitive edge. Thus, the incentive is not too great for contractors to staunchly resist wage demands.[31]

When the economy is in a recession and construction activity is low, the local unions seek help from the national hierarchy and they tend to seek incorporation of national agreements into local contracts to protect their share of the construction market from open shop encroachment. Thus, the fragmentation of organized labor has worked to exploit the fragmentation of construction contractors by gaining phenomenal wage increases. The inflated cost of construction has prompted the rise of open shop contractors and the use of other techniques such as prefabrication and in-house construction personnel to the long range detriment of labor unions.[32]

2.3.4.3 Design Professionals

Architects and engineers are another significant group involved in the construction industry. They design the structures that are to be built and they, too, tend to be a fragmented group of numerous firms which usually specialize in various fields - architecture, structural, mechanical, civil, electrical, foundation, environmental, etc. Architecture and engineering firms are usually very small, employing an average of only 8 professional people.[33] On a typical vertical project the architect is the lead designer. He contracts with the owner to produce the plans and

specifications and oversee the construction. The architect then retains firms involved in other disciplines to provide additional expertise. Thus, the design is produced by a number of firms in the same way that construction is produced by a number of contractors.

Architects and engineers (A-E) have also tried to remove themselves both physically and legally from the construction process. Frequent court judgments against A-E's because of construction accidents and failures are major factors in driving up the cost of professional liability insurance. Many times the A-E's become targets of suits even though there is no apparent contribution to an accident on their part. Since many contractors are shielded from a suit by workman's compensation law, the A-E is the next target. Thus, at a time when projects are becoming more complex and the designer has much more of a need to gain knowledge from the field, he is staying away from the job site for legal reasons.

A-E's have come under fire in recent years for elaborate designs, lack of coordination among disciplines, poor estimating, and poor cost control. One of the problems is that architectural and engineering education programs give little emphasis to the subjects of estimating or cost engineering. Peter Blake, an architect commenting on the state of architecture said, "Expressing structure is driving builders mad, driving clients into bankruptcy and driving architects into premature graves."[34]

2.3.4.4 Integrating Forces

The fragmented construction industry and its participants are showing some signs of integrating forces to bring the process back together. In some cases, architects and engineers are combining to provide a broad range of services within the firm. Out of the 1975 Engineering News Record's (ENR) top 500 design firms, 54 were listed separately as design-constructors; with the top 16 doing a combined total of $36 billion of construction work, with none of these 16 doing less than $1 billion each. The $46.4 billion awarded to design-construction was up 46 percent from 1973. Of the straight design firms, 41 out of the top 50 (82 percent) provided construction management services, while 206 out of

the entire top 446 (46 percent) also provided these services.[35] Construction management will be discussed in detail in Chapter 4; however, the trends indicate there are forces in the industry seeking to integrate the design and construction processes. Many of the design-constructors are also listed in the ENR's top 400 construction companies. In fact, the top 14 construction companies in 1974 all provided design services as well as construction. All but two of these firms provided CM services as well.[36]

The construction industry is under great stress. As projects become more complex, as environmental and energy factors concern designers and even the operations of contractors, and as owners become less patient because of inflationary forces, some segments of the fragmented world of construction seek to become more integrated to overcome these "hurdles." Considerable uncertainty must prevail concerning the future state of construction. When economic recovery does become complete and construction again nears full employment, will the industry face outrageously inflated wage demands? What about the national labor shortage that Drucker predicts to begin in the late seventies, due to a decline in the birthrate following the "baby-boom" years?[37] What will this do to a labor-intensive industry such as construction? Every owner who procures contract construction must be sensitive to the changes in the construction industry environment to determine how it will affect himself and his organization.

2.4 Summary

This chapter attempted to provide the goals and objectives in support of which Navy construction is performed. The environment in which construction is pursued in support of the organizational objectives has a significant effect on the responsiveness and effectiveness of new facility production. This environment contains the constraints that must be overcome and the resources that must be employed to provide new facilities for the Navy. The next chapter will outline how facility requirements are presently transformed into completed projects.

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CHAPTER 3

THE EXISTING NAVY FACILITY PROCUREMENT SYSTEM

3.1 General

The process of major facility procurement by the Navy is divided into three phases: planning, programming and implementation. A thorough understanding of the mechanics of turning requirements into completed construction is necessary before alternative systems can be contemplated.

3.2 Shore Installations and Facilities Planning and Programming System

The first two phases are encompassed by the Shore Installations and Facilities Planning and Programming System (SIFPPS). This is perhaps one of the most comprehensive planning systems developed by any organization. The aim of the system is to ensure that resources allocated for shore facilities are in balance with the requirements of Navy operating forces and approved Navy programs.[1]

3.2.1 Facilities Planning

The system begins with assembling the support requirements of the Navy and after numerous steps, it evolves into specific definitive construction projects. The segments of the SIFPPS process are:

(1) Logistic Support Requirement

(2) Basic Facilities Requirements List

(3) Evaluations of Existing Shore Facility Assets

(4) Summary of Facility Excesses and Deficiencies

(5) Correction of Facilities Deficiencies

(6) Program Objectives

3.2.1.1 Logistic Support Requirement (LSR)

The LSR is the means by which all tasks, functions and workload of a shore activity or command projected over an eight-year period, are identified and analyzed. This essential planning information for each activity is delineated by:

(a) Mission, tasks and functions

(b) Activity organization and staffing requirements

(c) Interdependent relationships with other activities

(d) Loading plans (projection of personnel, ships, aircraft, etc.)

(e) Equipment inventories and allowances

(f) Workload analyses[2]

The LSR is limited to peacetime planning, and is not intended to identify support required for contingency or mobilization plans.[3] The LSR prepared by each shore activity must be approved by all superiors in that activity's chain of command up to and including the Chief of Naval Operations, since a shore installation's projected workload is normally a function of high-level Navy and DOD planning. The LSR serves as the basis for determining, developing and validating all facility requirements.

3.2.1.2 Basic Facilities Requirements List (BFRL)

The BFRL enumerates the essential facilities required for the activity to perform its missions, tasks, functions and workload as outlined in its approved LSR.[4] The BFRL denotes the facility requirements

(1) By type using standard Navy category codes and

(2) By quantities standard for each code

For example, U.S. Naval Station, Anyport, FL may require

(1) 10,000 FB (Feet of Ship Berthing) of General Purpose Berthing Pier

(2) 600 MN (Men) Bachelor Enlisted Quarters

(3) 25,000 SF (Square Feet) of Adminstrative Space

These requirements are determined with the aid of published Navy planning guidelines, and they are zero-base in nature; that is, they are listed without regard to existing facilities. They are just what the name says - basic requirements. The BFRL is prepared by each major shore-activity, reviewed by the cognizant Engineering Field Division for technical adequacy, and submitted through the activity's chain of command to NAVFAC for approval.[5]

3.2.1.3 Evaluations of Existing Shore Facility Assets

The purposes of this step in the planning process are as follows:

(1) To determine to what extent that existing facilities of an activity satisfy the facility requirements established by the BFRL.

(2) To physically inspect the existing facilities to determine structural conditions.

(3) To recommend changes in the current use of facilities in order to achieve the optimum use of existing facilities to satisfy military, operational and functional requirements.

(4) To determine if existing facilities, presently inadequate, can be adapted to satisfy basic facility requirements.

(5) To recommend, when feasible, that a basic facility requirement be modified to permit acceptance of something less than complete satisfaction in order to make use of existing assets.

(6) To identify obsolete facilities that should be removed.

(7) To determine facilities excess to basic requirements that may be reassigned or disposed of.[6]

The cognizant EFD performs the on-site evaluations at shore activities at approximate frequencies of two years. The evaluation serves as the step where the basic requirements are meshed with the existing facility assets.

3.2.1.4 Summary of Facility Deficiencies and Excesses

The purpose of this summary is to provide all echelons of command with information relating to the extent to which basic facility requirements are not fulfilled by existing assets. It also provides initial information as to the extent to which existing assets may exceed an individually

categorized requirement.[7] This report serves as a vehicle for development of construction and/or demolition projects. It can also be used to transfer functions from a "deficient" site to an "excess" site - a sort of facility resource leveling.

3.2.1.5 Correction of Facilities Deficiencies

The purpose of this summary prepared by each activity with deficiencies is to initiate incorporation of facility projects over $50,000 into the Military Construction Program. The summary of deficiencies discussed in the previous paragraph is used to determine the specific projects required. The projects are listed (with other projects) in priority order at each activity. The EFD assists in the preparation of this document to ensure: (1) that projects are identified in an effective and logical manner, (2) that they correspond with the activities master plan, and (3) to give a rough estimate of project cost. This report is submitted through each activity's chain of command to its Superior-in-Command, which is usually a major naval operational or support command (i.e., Commander-in-Chief, Pacific Fleet; Commander-in-Chief, Atlantic Fleet; Naval Material Command, etc.) In the planning realm of the Navy these commands are referred to as major claimants, since they are the functional commanders and resource allocators for large segments of the Navy. At this level the project priorities within major command structures are determined. This report is used to formulate the multi-year Military Construction Program prepared by NAVFAC.[8]

3.2.1.6 Military Construction Program Objectives (MILCON PO)

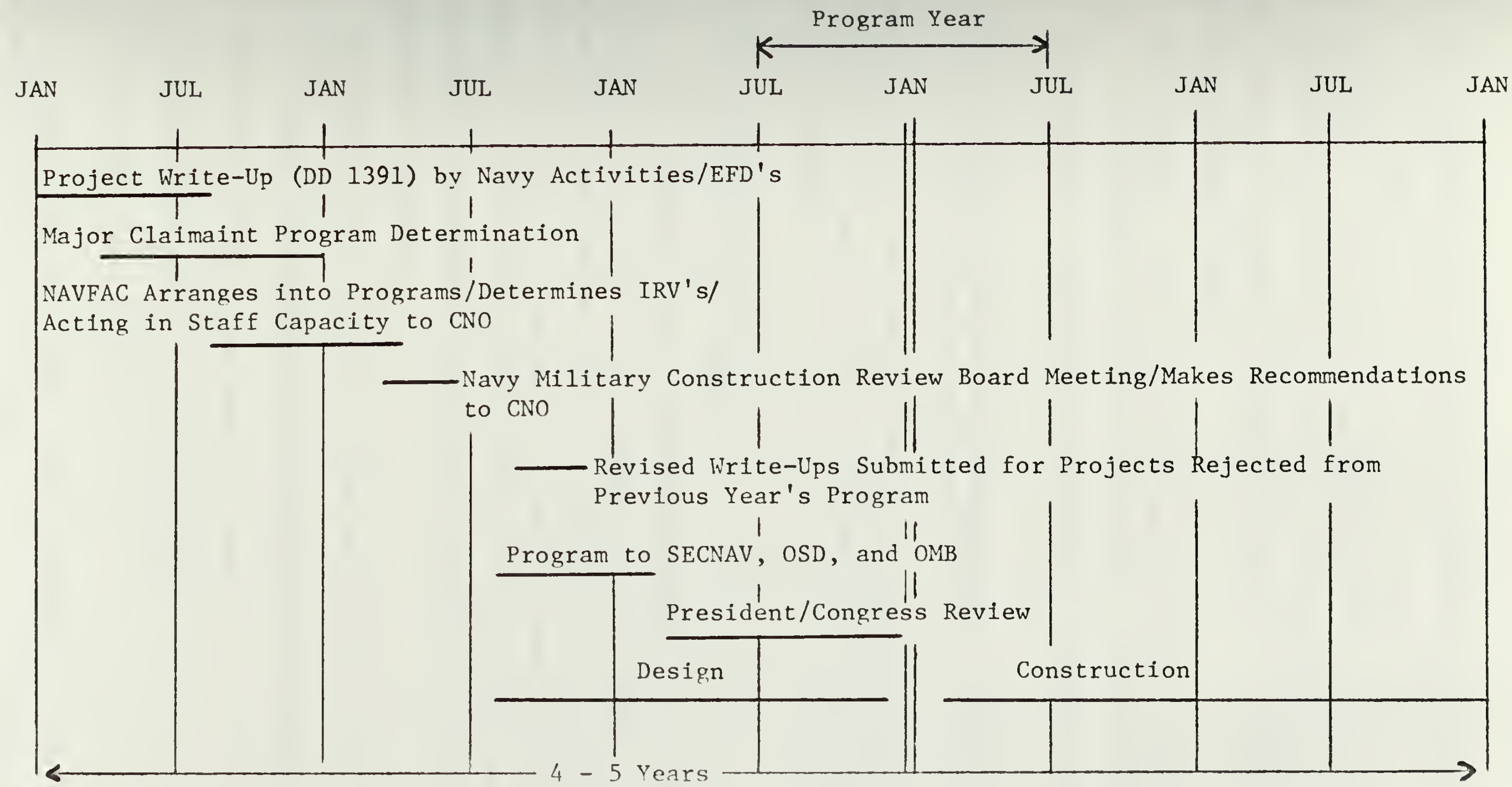
This is a report prepared by NAVFAC for all interested parties which shows the proposed programming of military construction projects by fiscal year. The MILCON PO can be used by an activity or command to determine the general status of a project, to see if the project information held by NAVFAC is valid, and to identify projects on which further detailed development needs to be accomplished because of their inclusion in an upcoming program. The Military Construction Program Objectives, the final output of the Shore Installations and Facilities Planning and Programming System, is the Construction Annex to the Secretary of the

Navy's Program Objectives which projects Navy resource levels, procurements, Research and Development, and supporting programs for five years and the force level objectives for three years.[9]

SIFPPS then is a comprehensive and logical step by step system that identifies the Navy's facilities deficiencies based on valid and substantiated requirements. It is an economical system, in that extensive engineering required for the preparation of detailed project write-ups and cost estimates are applied only to those deficiencies which appear certain for inclusion in next fiscal year's budget. By providing accurate knowledge of the Navy's total facilities picture, it allows the Chief of Naval Operations (CNO) and other major commanders to make meaningful mission and workload assignments. Also, CNO and the Secretary of the Navy can make decisions on the size of the Military Construction budget with a more accurate knowledge of their implication.[10]

3.2.2 Construction Programming

The distinction between where planning ends and programming begins is not perfectly clear. Up to now, the SIFFPS has not been tied to a specific time schedule because planning is a continuous effort. When requirements change, the planning must also adjust. Ideally, then changes in support requirement should be reflected immediately in the Logistic Support Requirement, and subsequent planning documents adjusted in response. Actually, each activity's LSR is updated annually and as a result changes, if significant, may be reflected in the Basic Facilities Requirements List and other planning documents. In general, the planning process is continuous and responds mostly to changes in requirements. Programming then is the process by which the products of planning are assembled into a military construction proposal, and the proposal scheduled through the various approval levels until it is ultimately approved by Congress. The programming cycle for typical MILCON projects is shown in Fig. 3.1. This chart also shows a common implementation or construction time to give the reader some feel for the length of the overall time cycle.


Program Year
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Project Write-Up (DD 1391) by Navy Activities/EFD's
Major Claimaint Program Determination
NAVFAC Arranges into Programs/Determines IRV's/
Acting in Staff Capacity to CNO
Navy Military Construction Review Board Meeting/Makes Recommendations
to CNO
Revised Write-Ups Submitted for Projects Rejected from
Previous Year's Program
Program to SECNAV, OSD, and OMB
President/Congress Review
Design
Construction
4 - 5 Years

3.2.2.1 MILCON Program Objectives and Construction Planning

The MILCON PO is the step where construction programming emerges. The multi-year construction programming method used by NAVFAC is designed to correct facilities deficiencies at a balanced rate within an established time frame as permitted by budget constraints.[11] The deficiencies are categorized into three areas:

(1) Investment categories which are facilities grouped into types such as Training, Waterfront Operations, Personnel Support, etc.

(2) Investment programs to implement or improve an entire functional system.

(3) Investment programs for accomplishment of master plans for specific shore activities or complexes.[12]

Items (2) and (3) are basically emphasis programs. After their share of the budget has been determined, the remainder of the dollars available are used in investment category groups.

3.2.2.2 Priority Determination

The allocations of resources for projects in investment categories groups is a most difficult task since the deficiencies in this category far exceed the annual budget. Thus, a priority rating system is used to determine the allocation of dollars to a major claimant within each investment category. An Item Rating Value (IRV) is computed for each project by a computerized, mathematical model which consists of the following five independent factors:

(1) Mission of the activity where the project is to be located

(2) Degree of deficiency the project is to overcome

(3) Type of project expressed by category code

(4) Economic aspects of the investment

(5) Major claimant priority.[13]

Those projects with the highest IRV's contribute to the total allocation for an investment category. The dollar total of each major claimant's projects

that have entered into this total allocation is the amount that the major claimint has available in that investment category. The major claimant may rearrange the order or priority of his projects for the upcoming budget year, but he is constrained by his total allocation within each investment category. Each of the major claimant's remaining projects over and above his allocation are programmed for future years. This procedure is followed for each of the investment categories for the five ensuing years.[14]

3.2.2.3 Project Write-Up

When each major claimant knows his allocation for the program year, he directs his activities to prepare project data sheet (DD1391) and a facility study (DD1391c). A DD1391 is submitted on each project. This form describes the size of the structure and the type of construction, itemizes the cost estimate, provides quantitative data covering the total requirement for and the availability of like facilities at the activity, and gives a concise statement of the requirement for the proposed project including the impact if the project is not provided.[15] The DD1391c is used to further explain the requirement. A DD1390 is also submitted which is a summary of the MILCON program at each activity plus information on the activity itself, including the mission of the base and present and projected personnel strengths. These documents are extremely important in that they are the ones that are eventually reviewed by Congress. Each activity submits its program year projects to its Major Claimant via its EFD for technical approval. Each Major Claimant then submits its program to NAVFAC for collation and preparation for the Military Construction Review Board.

3.2.2.4 Navy Military Construction Review Board (NMCRB)

The NMCRB's purpose is to recommend to CNO the total MILCON program to best support naval operating forces and implement approved programs of the Navy. The voting members of the board consist of representatives of each of the Major Claimants. Functional, technical and other staff advisors are also members of the board who assist with back-up information to the voting members. The Navy Military Construction Review Board reviews

the tentative program objectives by investment category, within which each project is scrutinized. The Board develops an integrated priority list for each investment category within the established budgeting levels, and submits it to CNO for approval.[16]

3.2.2.5 Commencement of Design

Once a project clears the NMCRB and is approved by CNO, design for the project is usually authorized. Apparently, this is done for two purposes. First, it allows the Navy to get a jump on the implementation of its program, since the funds for construction probably will not be made available for another year or year and a half when Congress acts on the measure. Secondly, it allows the Navy to have a more firm cost estimate in its presentation of the MILCON program to the Secretary of Defense (SECDEF), Office of Management and Budget, and President, and the Congress. By the time the program gets to the Congressional hearing stage, the configuration of the project should be defined well enough to have a much firmer estimate of construction costs. A few projects in the program will not survive the Congressional hearings, and the design will have to be stopped and shelved or cancelled completely. The philosophy behind this seems to be that the amount of time gained in getting into the construction phase for the bulk of the projects that will be approved more than offsets the loss of money spent for cancelled and unused design work.

3.2.2.6 Navy and Defense Departments Review

The MILCON program goes to the Comptroller of the Navy (NAVCOMPT) in August of each year prior to the MILCON program year which begins the next 1 July. The Secretary of the Navy (SECNAV) makes final decisions on the NAVCOMPT recommendations before submitting the program to the Office of the Secretary of Defense (OSD) on or about 1 October.[17] An intensive review of each project is conducted at this level, with the Office of Management and Budget (OMB) participating. Formal hearings are held in which the Navy must justify its requirements. The Assistant Secretary of Defense for Installations and Logistics (OASD(I&L)) also conducts a technical review of the proposed construction methods, types of structures and cost estimates to ensure compliance with OSD criteria and unit prices, and also

to ensure that the engineering is sound.[18] Upon completion of the reviews OSD decides upon the firm budget for next fiscal year. This may reflect some different projects than originally submitted since by this time the Congress will have acted on the previous MILCON program, and projects which did not survive this year may displace other projects in the upcoming program, and since SECNAV submitted the budget other events may have occurred that could introduce new projects and eliminate old ones.[19]

After the Secretary of Defense approves the budget and it is concurred with by the Office of Management and Budget and the President, the military construction programs of the three services and other Defense Agencies are consolidated in the Department of Defense Military Construction Authorization Bill and the DOD Military Construction Appropriation Bill for submission to Congress.[20]

3.2.2.7 Congressional Review and Approval

For the MILCON Program to become a reality, both the authorization and appropriation act must be passed. The Authorization Bill is presented first, and is reviewed by the Armed Services Committees (ASC) of the House of Representatives and the Senate. Each of these committees has a professional staff which does an on-site investigation of proposed construction sites, and each ASC has a subcommittee on Military Construction that holds formal hearings to review the MILCON program.[21]

Title II of the Authorization Act reflects the projects which are authorized and the total dollar volume authorized at each Navy installation. The committee report which does not become law cites the authorized amount for each project which is used by the Navy as a control figure since it is the intent of the Congress. The differences in the House and Senate versions is hammered out in a conference held before passage by each legislative body. The authorization is good for two years, after which if a project is not started, reauthorization is requested. The Authorization Act also contains continuing authorizations for such items as planning and emergency construction. Over the past ten years the authorization has ranged from 5 to 15 percent less than requested with an average 8.4 percent reduction.[22]

The Appropriation Act provides the funds for the projects authorized. The bill is reviewed by the Military Construction Subcommittees of the House and Senate Appropriations Committees. The Appropriations Act cannot be passed until the Authorization Act is law; however, in the interest of time the hearings on appropriations do begin before the authorization is passed. The House subcommittee meets first and usually conducts the most detailed examination of the program.[23] The House and Senate versions are negotiated in a conference committee to become compatible before enactment as law.

The Appropriations Act grants a lump sum authorization to be spent on projects and installations contained in the Authorization Act. However, if the Report of the Conference Committee indicates that certain projects will not be funded, this is just as binding as if it were law. The amount appropriated has varied in the past ten years from 75 to 95 percent of the amount requested with an average of 86 percent.[24]

Through all of the hearings the Commander of NAVFAC serves as the Navy's chief witness. He must respond on the spot to questions posed by the committee members on individual projects. The Commander brings back-up information and staff experts to the meetings, due to the broad character of questions posed by the committees.

One feature of the existing system that presents some problems in executing the program is the time of passage of the two acts. In the past ten years the Authorization Act has been signed once in July, once in August, twice in September, four times in October, once in November and once in December.[25] In the same time period the Appropriations Act has been enacted three times in September, once in October, twice in November, and four times in December.[26] Since the fiscal year begins on the first of July, nearly half of the MILCON program year is gone before the projects are authorized and funds appropriated.

Some relief for this system may be in sight, however. FY77 will begin on 1 October 1976 vice 1 July 1976, due to the Budget Reform Act of 1974. Under the new system, authorizations and appropriations are due for enactment prior to the start of the fiscal year in which the program is to

be executed. Under consideration is a proposal to authorize the program a year in advance of the program year.[27] The change to the system has kept the MILCON time cycle in a state of flux over the past few years, but the total time from project submission to construction completion remains about the same as shown in Fig. 3.2.

The continuing authorization and appropriation for planning does allow the design of future projects not yet acted on, as mentioned earlier. This gives the Navy a considerable head start in getting the project into construction after approval of the program by Congress. However, these design funds are limited to 6 percent of the total of the facilities projects.[28] As shown in Fig. 3.2 this authority is now being used to commence designs up to two years in advance of the appropriation.

Another feature of the Authorization Act is the limits it places upon project escalation, above which Congressional approval must be granted. The act usually permits escalation by 5 percent of the installation total in the U.S., and by 10 percent outside the U.S. However, the total still may not exceed the total amount appropriated. Individual projects may be escalated up to 25 percent, but the installation totals must remain within the 5 percent/10 percent requirements. The Authorization Act also requires that construction work within the U.S. be performed by contract.[29]

3.2.2.8 Execution of Approved MILCON Program

Enactment of the Authorization and Appropriations Acts does not make the funds instantly available for the award of construction contracts. Contracts may be advertised upon enactment, but awards cannot take place until the funds are apportioned by the Office of Management and Budget. The apportionment is requested through the Comptroller of the Navy, the Office of the Secretary of Defense, and eventually up to OMB. The funds flow back down in a like manner. At each review level, the projects proposed for funding are examined to ensure they fall within the authorized scope, that they are still required, that base rights

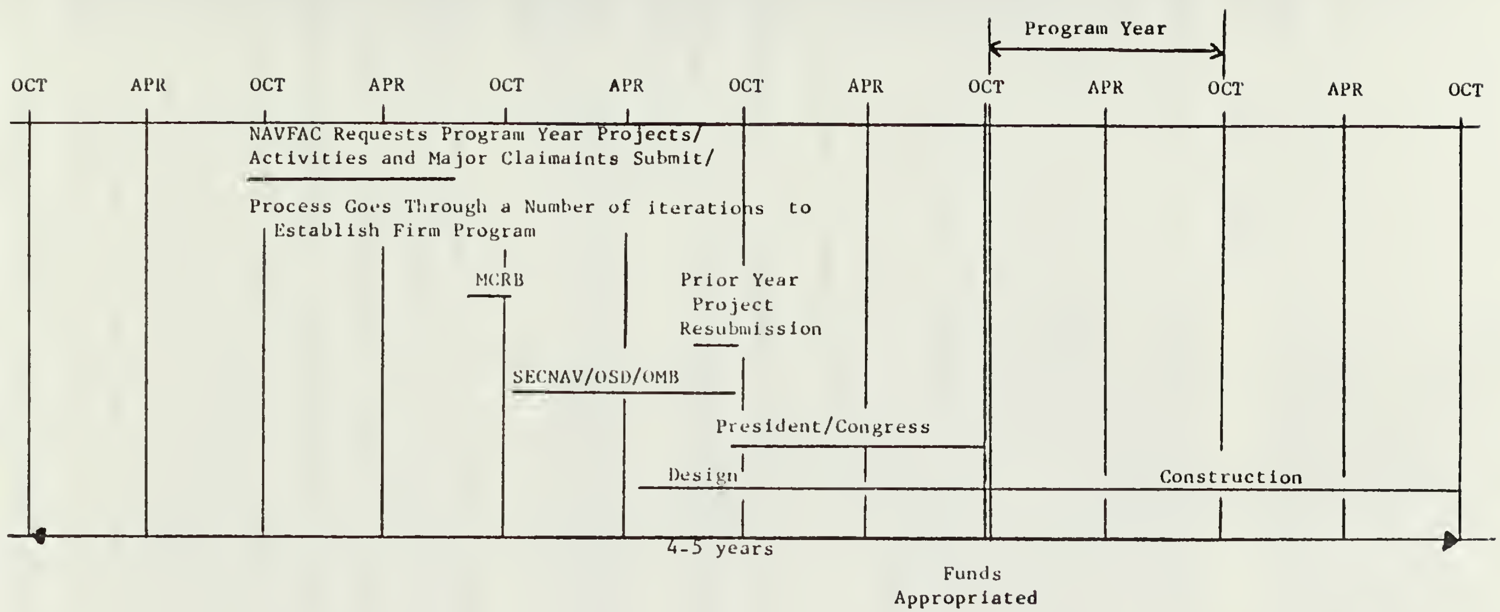

Fig. 3.2. Revised MILCON Time Cycle.

exist for overseas projects, that all special clearances have been obtained and that they are not affected by proposed base closures.[30] In the past ten years the time for receiving the first apportionment document has ranged from 6 to 57 days with a 10 year average of 35 days.[31] NAVFAC manages the apportionment requests to ensure they are requested in a timely manner.

Operating in a decentralized manner NAVFAC assigns the projects and the funds received to its EFD's for implementation. To assist the EFD in effectively managing their assigned MILCON program, the EFD's are issued what is called a compensating assignment. Since the Appropriations Act usually underfunds the Authorization Act, careful management of the funds provided must be exercised to maximize the number of projects which can be accomplished. The total cost estimate as authorized includes:

(1) The estimated contract award price,

(2) A contingency for change orders of 5 to 10 percent,

(3) Government supervision, inspection and overhead costs (SIDH) of 6 percent, and

(4) A cost escalation factor of up to 10 percent per year to adjust for the time lag between the planning phase and the construction phase.[32]

Experience has shown that the total estimated cost is not always required to complete a project, or at least it is not required at the start of a project and may not be needed for some time thereafter. In order to prevent needlessly tying up funds, program assignments are made to each EFD on the basis of the current working estimate (CWE) which is the estimated contract cost plus Government supervision, inspection and overhead. The contingencies for all projects within each EFD's area are grouped together and assigned to that EFD in a single lump sum amount called a compensating assignment.[33] Thus, the EFD has some flexibility in allocating extra funds where needed, though the maximum escalation on specific projects and at installations still is controlled by the Authorization Act.

3.3 MILCON Program Implementation

3.3.1 Design

As mentioned in the previous section, when the NMCRB finishes with a Military Construction proposal NAVFAC usually authorizes final design for those projects in the program.

3.3.1.1 A-E Selection

Design firms interested in doing Navy work keep qualification statements and brochures on file at the EFD's. On each project a slate committee composed of NAVFAC professional engineers and architects meets to screen all available firms in terms of experience, performance, and capabilities. The result is the selection of five to eight firms with which to conduct interviews. A selection board then meets to interview these firms. The interviews cover

(1) Explanation of the scope of project

(2) Determination of the A-E's ability to meet the time schedule

(3) The A-E's presentation of similar work he has performed

(4) The A-E's explanation of his organization and key personnel he has available to work on the project

A secret ballot of the selection members is taken and the winning firm is asked to submit a fee proposal. Up until this point no mention is made of price. A government estimate of the fee is made, and a fee negotiation board is convened to negotiate face to face with the A-E. The board resolves differences in the scope of work, time schedule and A-E's fee. If no agreement can be reached, the second firm that the selection board recommended is negotiated with in a like manner.[34]

3.3.1.2 A-E Contract

Upon agreement with a firm, a contract between the A-E and the Government is signed. The Commander of the EFD is the contracting officer on A-E contracts as he is for construction contracts.

Some features of the Navy-A-E contract are:

(1) The A-E usually is required to check shop drawings and provide as-built drawings as a part of his basic fee.[35]

(2) Field consultation as necessary to ensure compliance with designers' intent may be required, and if so, it will be on a reimbursed basis.[36]

(3) If the bids for construction exceed the amount allowed, then the A-E is obligated to redesign at no additional cost to the Government.[37]

A member of the design division of the EFD is designated as Engineer-in-Charge (EIC) to administer the A-E contract during the design stage. He coordinates the design work of the A-E with the government organizations concerned with the projects and assists the A-E in the interface with government procedures. The A-E is required to use federal and military specifications where applicable, and is required to follow the format used for NAVFAC contracts, including assembling the contract and adding the government "boilerplate."

The design usually will have three required submission and review stages - at 30 percent, 100 percent, and the finalized package of plans and specifications. At 30 percent, the A-E may be required to prepare some supporting documentation for projects which are to go before Congress. In this system, which will interface with the new fiscal year and budget review procedure installed by the Budget Reform Act of 1974, the design contract will be a two part contract. The first part is for the first 30 percent including the preparation of supporting documentation, and the second part is for completion of the plans and specifications. Under this system, part one is negotiated with an option to negotiate part two if NAVFAC considers the chances of surviving the Congressional review good.[39]

The Navy's participation in the design is mostly by EFD design personnel and some input from the using activity, especially with regard to their requirements. The EFD Construction Division and ROICC Office involved is given a set of plans to review at the 100 percent stage.

The A-E is paid on a monthly percentage of the design work he has completed. In general, NAVFAC construction projects are designed completely before commencing with construction.

3.3.2 Advertisement, Bid and Award

Upon completion of the design, the construction contract is advertised by mailing Invitations to Bid (IFB) to contractors who would bid on that particular type of work. On contracts under $500,000 the bidding may be restricted to "small business" contractors. IFB's are also posted in public places, and a synopsis of the potential project is listed in the Commerce Business Daily published by the U.S. Department of Commerce. The EFD contract division ensures that all contractors who have requested plans and specifications receive any copies of addenda that are issued prior to the bid opening, so that everyone is bidding on the same basis. In some cases of very complex projects, a prebid conference is held with the design division and A-E explaining some aspects to potential bidders. All the bids are opened at a public meeting where they are read and recorded. No determination is made as to who will be awarded the contract at that time, although it is generally obvious who is the apparent low bidder. Sometimes, though, the bid may contain a number of alternates that must be bid in addition to the basic bid item. In this case, the successful bidder will be the one who provides the base item plus the maximum number of alternates for the lowest cost and within the allocated amount.

The basic requirement is that the award be made to the lowest responsive, responsible bidder.[40] "Responsive" means that the bid has been submitted as instructed and the bid has not been qualified in any manner. There can be no negotiations between the government and a bidder prior to award of the contract, in order to provide a uniform standard for all the contractors to bid on.

The other technique employed by NAVFAC to ensure that all bidders are bidding from the same information, is to have bidders recognize the addendum numbers they have received on the face of their bid.[41] Failure to do this can result in a nonresponsive bid that can be eliminated from award consideration. Contractors are also required to submit a bid

security with their bids, which usually amounts to 20 percent of the bid price.[42] Failure to do this also makes the bid nonresponsive and unacceptable.

On government contracts, if a low bid is significantly lower than that of the rest of the bidders and the government's estimate, the bidder is allowed to reconsider his bid. If he finds he has made a mistake he may withdraw his bid, but he is not allowed to modify the price. In this instance he will not lose his bid bond.

A "responsible" bidder is one who has the capacity to perform the work and the integrity to honor his obligations under the contract. When the lowest responsive, responsible bidder is determined, the contract is awarded. The successful contractor is presented with a notice of award; however, he must complete certain requirements before construction can begin.

3.3.3 Construction

3.3.3.1 Post Award Period

The two major documents needed are the contractor's performance and payment bond, which amount to 100 percent and 50 percent of the contract price, respectively.[44] The certificate of the contractor's insurance policies must be submitted, showing he carries the minimum required coverages. Upon receipt of these documents, the contractor is given notice to proceed by the OICC who is the commander of an EFD or a separate OICC as discussed earlier in the previous chapter.

At this stage of the contract the Resident Officer in Charge of Construction (ROICC) becomes the key contact for the contractor. Before construction begins, a conference between the contractor and the ROICC is held. At this meeting, called the "preconstruction conference," the ROICC has people from his office who will be concerned with this particular contract - namely the Assistant ROICC assigned, the construction representatives (inspectors), and the construction engineer. He may invite other base personnel to participate in order to familiarize the contractor with

safety, security and fire regulations aboard the respective Navy installation. The facilities management or public works personnel from the base at which work is being done may also attend, since their activity will become the user of the new facility. The contractor usually brings the key participants in his organization who will be involved in this contract such as the project engineer, the superintendent and key subcontractors.

This meeting is primarily to establish lines of communication and settle administrative matters, rather than to discuss the technical aspects of the job. The ROICC explains the roles of his AROICC, construction representatives, and office personnel and also the appropriate channels of communications to use. Basically, the contractor works through the AROICC assigned to the project. The contractor introduces and explains the roles of his job site representatives and subcontractors.

The ROICC stresses important features of the contract such as

(1) Completion dates,

(2) Pertinent general clauses,

(3) Liquidated damages,

(4) Roads and gates to be used,

(5) Hours in which contractor can work,

(6) Testing requirements,

(7) Shop drawing requirements,

(8) Physical condition of the site (cleanliness),

(9) Safety requirements,

(10) Required labor standards such as the Davis-Bacon wage rates,

(11) Arrangements for utilities,

(12) Procedures for change orders and

(13) Value engineering incentives.

The contractor is also requested to turn in his schedule of prices as soon as possible to facilitate the monthly payment and change order

process. A schedule of prices is a breakdown of the job into its major components, with a percentage of the total project cost assigned to each component. The overhead and profits are distributed into all these items. This document is used to evaluate requests for progress payments, and to assist in determining the equitable amount to adjust the contract for change orders.

3.3.3.2 Resident Officer in Charge of Construction

The contractor's day-to-day relationship is with the ROICC who performs the field administration of the contract for the Navy. The ROICC's job can be a demanding one, since all the problems embedded in the planning and design of a job generally surface in the construction phase.

The ROICC's organization and size can vary greatly, depending on the amount and nature of work in an ROICC's assigned geographical area and the relative remoteness of the site. A typical organization chart is shown in Fig. 2.6. The solid lines indicate the absolute minimum organization while the dashed lines represent segments of an ROICC staff commonly found in existence.

The Administrative Division handles the paperwork associated with the contracts. A file is kept on each contract containing pertinent correspondence concerning that job. On large contracts the file for one project can be quite extensive. The Administrative Division also ensures that the mass of reports the ROICC is required to make are submitted. These reports are generally sent to the cognizant EFD, and mostly they concern the progress of the projects under ROICC's direction.

The other two components of the ROICC's organization are concerned with his project management functions. The technical division is usually staffed with professional engineers who perform a wide variety of tasks, which include:

(1) Reviewing the plans and specifications for construction problems prior to advertisement,

(2) Preparing government estimates for changes,

(3) Coordinating design problems with the A-E,

(4) Reviewing contractors' submissions (such as the schedules of prices, shop drawings, material samples, value engineering requests),

(5) Evaluating change order requests,

(6) Coordinating the delivery of government-furnished material (GFM)

(7) Evaluating the results of testing, and all items which require a professional/technical treatment.

The other facet of the construction management functions is the inspection responsibility. The inspection division traditionally has been responsible for "riding herd" on the contractor to ensure compliance with the plans and specifications. These traditional functions have included

(1) Understanding the performance requirements, then

(2) Judging quality,

(3) Identifying items for submittal,

(4) Inspecting for compliance,

(5) Observing the total effort and progress of the contractor,

(6) Making off-site inspections at material plants, prefabrication sites, etc.

(7) Identifying unsafe work practices,

(8) Observing weather and climatic conditions,

(9) Reporting the size of the workforce and spot-checking to ensure employees are being paid the appropriate Davis-Bacon wages.

These functions are usually performed by experienced construction people who are civilian employees of the Navy. In a "typical" job one inspector usually is assigned as "lead" inspector. This inspector is augmented from time to time by inspectors or engineers with a specific qualification, such as an electrical, mechanical, or boiler man, to ensure compliance in regard to these particular areas.

3.3.3.3 New Inspection Strategies

A high premium has always been placed on getting the contract completed as smoothly and quickly as reasonably possible. Thus, the Navy has

maintained a fairly high level of inspection to avert and solve problems before they become big enough to delay moving into a long-awaited facility. Contractors have taken advantage of this high degree of inspection by reducing the level of supervision on the job, thus making the inspector a "quasi-supervisor." Another problem which relates to this "quasi-supervision" is one of liabilities incurred. As students of contract law know, the closer the "supervision" or "inspection" exercised over a contractor, the less the contractor is held liable for defective performance. The silence of inspectors can be equivalent to giving approval to the workmanship witnessed.

In order to combat (1) the reduction of supervision by contractors and (2) increased assumption of liability by the government, the Navy has been taking a new approach to ensure contract compliance while forcing the contractor to adequately supervise his project and holding him ultimately responsible for his quality. This fairly new system is called Contractor Quality Control (CQC). Under this program, which applies to jobs in excess of $1,000,000, the contractor is responsible for his own quality control. This is accomplished by requiring the contractors on these jobs to submit their own quality control plan before they are given notice to proceed. The plan must provide the name of the contractor's CQC representative, his technical experience and a copy of a letter giving him the authority to control quality on that job. This CQC inspector is an employee of the contractor, but he does not report to the superintendent. He must report to an official of the construction company off the site. He serves the same function as a Navy inspector by:

(1) Performing day-in, day-out inspections of the work to ensure compliance with the plans and specifications,

(2) Arranging for labs to perform required testing,

(3) Arranging for consultants to approve submittals,

(4) Arranging for specialty inspection, and

(5) Approving shop drawings.[45]

The Navy's role then becomes one of surveillance of the CQC representative. This is accomplished by spot checking to see that

(1) The CQC representative is at the project at critical times (i.e., concrete pours, etc.)

(2) Materials are acceptable,

(3) Certified submittals are in fact acceptable,

(4) Test results are within the specifications required.[46]

This system allows the Navy to hold the contractor more responsible for his own performance, and it forces him to maintain adequate supervision. In addition, it enables the Navy to spread its "inspectors" (who become construction representatives under this system) over more jobs.

Under the traditional system the Navy inspector submits a daily report on each of his contracts. This report provides information for his superiors on the progress of each job, but more importantly, it provides documentation for use in claims and/or disputes which may arise later. This report indicates environmental conditions, trades working, type of work in progress, material received on site, equipment on site, delays, accidents, defective work to be corrected, and any special remarks concerning the contract. Under the CQC system, the CQC representative is required to submit similar reports to the Navy construction representative.[47]

3.3.3.4 Change Orders

Another problem which confronts the field administrator of construction contracts is that of changes. Nearly every contract of substantial size is bound to contain numerous changes. For a change to qualify as a valid change order on a government contract, it must fall within one of the following categories:

(1) Design Change due to errors or improvements in design

(2) Changed Requirements of the government

(3) Differing Site Conditions from those found on the plans and from what reasonably should be expected

(4) Ripple Effect of a change on unchanged work

(5) Constructive Changes forced upon the contractor by overly strict interpretation of the contract.[48]

In evaluating a potential change order the ROICC must check to see if the change is within the scope of the contract. If it is, then an estimate must be made by the government. If the funds are available, the contractor is asked to submit a proposal. If the change order must be implemented immediately to prevent holding up the work, then the Navy may authorize the contractor to proceed as soon as it has been determined that there is enough money in the budget to do the job. Upon receipt of the contractor's proposal, the ROICC evaluates the contractor's estimate by comparing it to the government estimate. If the government estimate exceeds the contractor's estimate, then a change order is immediately issued and signed by both parties. Frequently the contractor's estimate is higher than the government estimate, so the ROICC and the contractor meet, discuss their differences, and try to negotiate a "fair and reasonable" price for the change. The contractor, in addition to being allowed direct labor, material and equipment for the change, is allowed his standard

(1) field overhead,

(2) home office overhead,

(3) engineering/drafting expenses,

(4) employee insurance expenses,

(5) additional bond expense (if any), and

(6) six percent for profit.[49]

3.3.3.5 Payments

Before any progress payment can be made the contractor must

(1) have signed the contract

(2) have performance and payment bonds submitted

(3) have submitted an approved schedule of prices, and

(4) have submitted an invoice which is reviewed, changed if necessary, and endorsed by the ROICC and forwarded to the OICC for preparation of the payment voucher.

The payment voucher is sent to a Navy Finance Center for preparation and mailing of the check to the contractor. The process usually takes about three weeks.

3.3.3.6 Final Inspection

When construction is completed in the eyes of the contractor, a final inspection is made. Deficiencies are noted which the contractor must correct before he receives his final payment. This list of deficiencies is called a "punch list." Many times a project is 99 percent complete, and the only delay may be a material item which has not been received. As one may well imagine, the prospective occupants of the new facility are anxious to move in. In this case a Beneficial Occupancy Date (BOD) inspection is held and the remaining items of the contract to be completed are noted, along with deficiencies which are to be corrected. After this inspection, the occupants can move in, but the contractor must still complete all items before final payment can be made. The effect of the BOD is that it usually establishes the commencement of the contract warranty period - a date which is of prime importance to the contractor.

The warranty period is usually for one year on most government contracts, with up to five years for specific mechanical installations. The ROICC is called upon frequently to determine whether a maintenance or repair requirement to a facility during its warranty period is a contractor obligation or due to damage by the occupants.

3.3.3.7 Phase Coordination

To ensure the coordination for the orderly progression of a project through the design, bid and construction phases, the EFD's have a group of individuals called project managers. Each project manager handles all projects within an assigned region. Project managers are usually not intimately involved with each assigned project, since they handle such a large number of jobs. Since each of the phases - design, bid, construct - are sequential, they are primarily managed by the design, contracts, and construction divisions respectively as the project passes through each stage. The project manager's function is highly oriented to the financial

aspects of each project, to ensure the funds required - for design, for construction award, for change orders - are available when needed. When constructing under the traditional technique of these distinct and sequential stages, the close coordination necessary when overlapping design and construction is not really as critical.

3.4 Summary

Discussion of the existing system of procuring contract construction for the Navy is not a simple matter. The construction itself is to contribute to the national defense and more specifically, to the mission of the Navy. The procurement process must exist in an environment which both constrains it and provides resources to accomplish its goals. The mechanics of procuring facilities begins with the comprehensive SIFFPS planning phase, then the projects are programmed and prepared for presentation to Congress. The design, bid and construction are performed in a sequential manner and culminate in the end products (new facilities) of the long, but sophisticated process. This sequential form of design, bid, construct shall hereafter be referred to as the "traditional method."

R E F E R E N C E S

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[6] Ibid., p. 4-18. [7] Ibid., p. 4-20.

[8] Ibid. [9] Ibid., p. 4-26.

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[12] Ibid., p. 4-27.

[13] Military Construction Program Management, NAVFAC P-328, Department of the Navy, Washington, D.C., June 1971, p. 2.8.

[14] Ibid., p. 2.8-2.9.

[15] Public Works Manual, Part A, op. cit., p. 4-31.

[16] Military Construction Program Management,NAVFAC P-328, op. cit., p. 2.9-2.10.

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[19] Ibid., pp. 3.7-3.8. [20] Ibid., p. 3.8.

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[43]Ibid., p. 4.7.1.

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CHAPTER 4

THE CM ALTERNATIVE

4.1 General

In the previous chapters, the goals of Navy construction, its environment, the resources and constraints that affect it have been discussed. The existing system that the Navy typically uses to plan, design and construct has also been introduced. This chapter will introduce the CM concept and method as it exists today.

4.2 Purpose of the CM Approach

It was noted in Chapter 1 that the emergence of CM was due to owner dissatisfaction, but what were the results that these CM's achieved? The primary objective of CM was to complete a project within the budget and in the shortest possible time. Due to the nature of its operation, the CM method in its different approach to designing and constructing, has also produced by-products that will become evident throughout this chapter.

4.3 Reasons for CM's Emergence

The problems which generated project cost and time schedule overruns were due to a number of factors. The first problem was a lack of competition among contractors bidding for construction contracts. This particularly has affected owners who take competitive bids, especially the ones in the public sector. Many of the most capable contractors have negotiated work in the private sector, and because it reduced the risk they had to take. Also, this type of work does not require the high quality contractor to bid on an "initial price only" basis against a "cutthroat" contractor, who will cut quality and make up for his initial low price in change orders.

A second reason for the "surfacing" of CM has been the size of many of today's construction projects. When these large projects are

imposed on the construction market which is made of primarily small contractors as noted in Chapter 2,

(a) the number of contractors with the capacity to bid is severely limited, and

(b) the risk to the firms that do bid is very high.

One large project can tie up a significant portion of a firm's capital and bonding capacity, as well as its fixed assets and management talent. Even the process of preparing a bid on a large project can be a costly matter when there is a good chance that another contractor may get the job. Due to the structure of the industry, a general contractor's bid strongly depends on the subcontractor's bids he receives for the 75 percent - 80 percent of the work they perform. Many times there is difficulty in getting the "subs" to commit themselves to a figure at an early date, particularly when their portion of the work may not even be required until a year to 18 months from the bidding date.

A third factor leading toward the development of CM has been the increasing complexity of today's projects. In development of project design, the architect and engineer need to know the impact of their decisions on the physical construction of the project. In highly complex structures, even minor design decisions can lead to suboptimal construction economy. Understanding the methods of construction and the local construction marketplace are essential to integrating the design and construction phase. The skills and knowledge that have been the stock and trade of the general contractor are now needed to an increasing degree in the decision and design phases of building generation.[1]

A fourth factor which pressed for an alternative to the traditional system was inflation itself. For sometime it has been vogue in business to say "time is money," but the rampant inflation of the last few years of at least 10 percent per year has made the message more valid than ever. The longer a project took to advertise and bid, the higher the quotes as prices continued to rise. The longer it took to construct the project, the more likely the contractor was to claim changes to make up for his escalation losses. As mentioned earlier, the general contractor has traditionally

borne the risk by bidding a lump sum fixed price project for the entire project. The longer the construction, the higher contingency the contractor had to allow for the uncertainty in the economic conditions. Thus, even the contractor's expectation of continued inflation was helping fuel more inflation.

A fifth reason for the emergence of CM was that many owners who are sophisticated professional managers in their own fields were becoming impatient with the antiquated management methods of construction. To these owners the construction process seemed unplanned, uncontrolled and unorganized. However, the apparent mismanagement of construction has not been because construction is full of inept managers. On the contrary, the industry is filled with tremendous human resources; however, the structure of the industry contributes more to management inefficiency than anything else. Most construction companies are below the critical corporate size where the development of managerial inputs and their applications are not inefficient. As noted in Chapter 2, construction companies have one of the highest rates of business failures in the country, and 85 percent of these are due to poor management.

4.4 Ways to Examine CM

The different approaches to examining the CM method to construction are shown in Fig. 4.1. The remainder of this chapter will discuss CM from each of these approaches.

4.5 The Concept of CM

A discussion of the CM concept is best initiated by delineating the roles of the participants in the construction process.

4.5.1 The Owner

First there is the owner who has a requirement for the facility and provides the funds to plan, design and construct it. He may or may not have a facilities engineering staff to assist in the procuring of this new facility. The less staff he has, the more he will need outside assistance in the development and construction of the project.

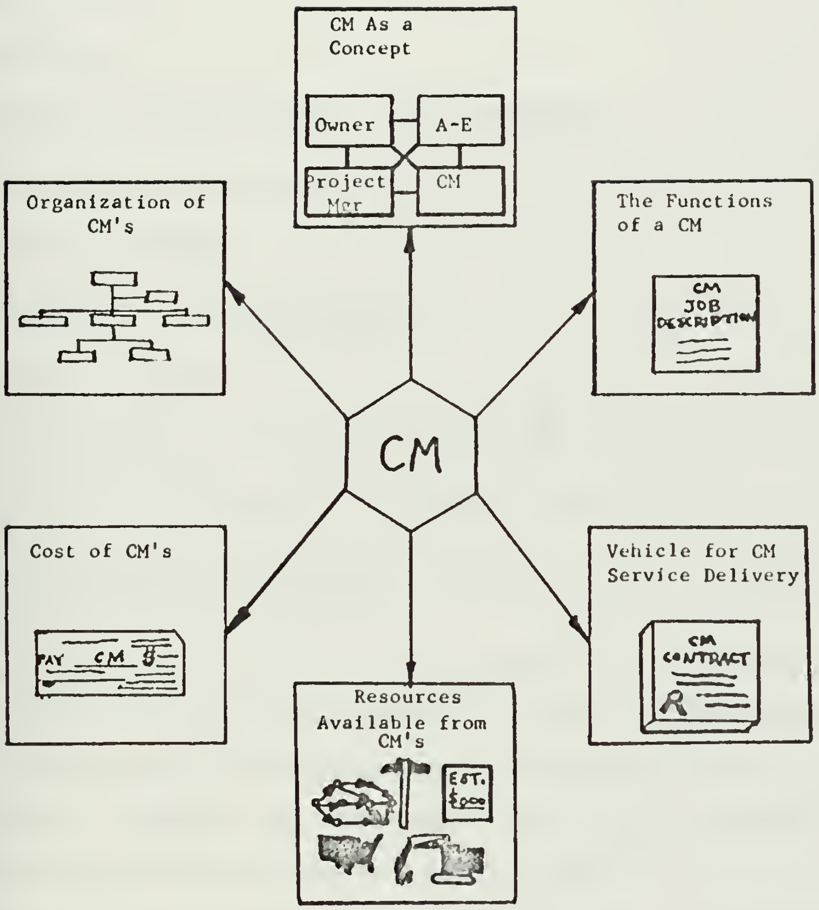


Fig. 4.1. Approaches to Examining CM.

4.5.2 The Project Manager

The next participant shall be designated as the project manager. This is the organization that is charged with the overall responsibility for the creation of the new facility, beginning with the development of a requirement through all stages to the completed product ready for use by the owner. The project manager is concerned with

(1) Project need,

(2) Feasibility,

(3) Overall project planning and programming,

(4) Real estate decisions,

(5) Public relations,

(6) Coordination with the owner,

(7) Project financing,

(8) Contract administration of professional and construction contracts,

(9) Evaluation of changes to planned actions, and

(10) The insurance that the owner's wishes, needs, and requirements are satisfied by the project.[3]

The project manager is the spokesman for the owner, and many times he has the authority for major decisions. This project management function is usually performed by the facilities engineering staffs of large sophisticated owners. However, an owner with no technical capability may retain an architect or engineer to perform these functions.

One of the most common misconceptions about the CM system is that the CM performs the project management function. As will be seen later in this section and throughout this chapter, the CM's functions are usually limited to the design and construction phases, and they are fairly well defined when working with a large complex owner.

The project manager as a decision point when using the CM system is a very critical aspect. Another misconception about the CM system is that the owner sits back and lets the CM run the job for him, and that the owner

has less involvement than ever in the facility production process. This could not be farther from the truth. The CM system is highly sensitive to close owner involvement and rapid decision making responses. If the benefits of CM are to be maximized, the owner must play a full participating role.[4] This is why CM is adaptable to huge diverse owners with large facilities staffs who can speak decisively for their owners in facilities matters. Thus, the project management concept is critical to the operation of CM for the large corporate or public client.

4.5.3 Design Professionals

The next participant is the architect and his associated engineers who design the project. Their responsibilities are somewhat affected by the CM systems because their normal operating procedures may be altered. The CM will work closely with them in the design phase to ensure that the technology, economics and marketability of the project are maximized. The A-E will have to conform to a schedule which coordinates his efforts with the actual construction. The A-E is usually relieved of estimating responsibility by the CM and may have fewer on-site requirements. The A-E/CM relationship is sometimes marked by conflict.[5] The A-E may feel the CM is imposing on his design perogative. However, the CM must be involved in the design phase to ensure that construction considerations are not neglected, as has been so common in the past. The A-E is still responsible for the quality of the plans and specifications, and he is not subordinate or superior to the CM during any phase of the project. Disputes between the A-E and CM are resolved by the project manager.[6] Most enlightened A-E's are learning the value of the contributions made by competent CM's and a cordial constructive working relationship becomes an important A-E and CM selection criterion for project managers to consider.

4.5.4 The CM

A fourth participant in the CM system is the CM himself. CM was defined in Chapter 1 and will be discussed in detail throughout the rest of this chapter. Basically, the CM provides the integrating function in the design and construction process. He brings construction skill to the design

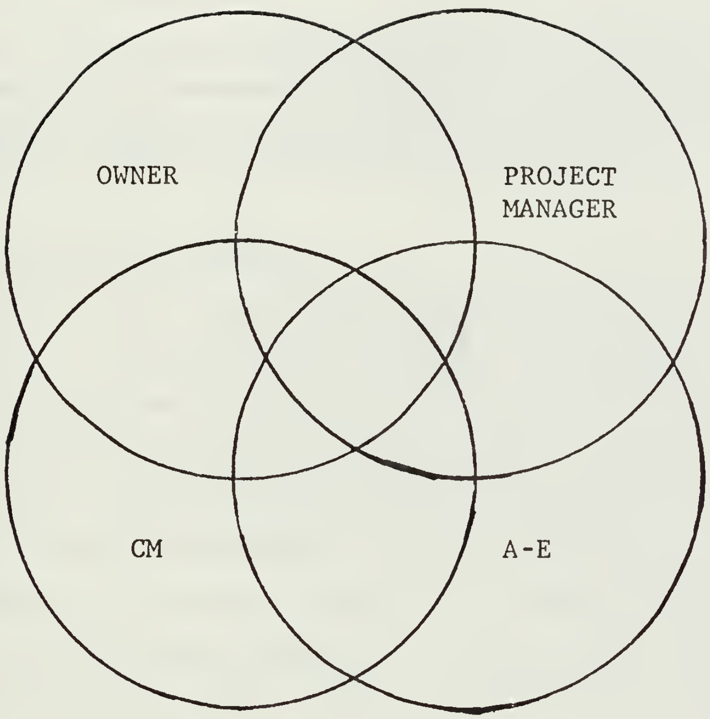
phase. He assumes the role of the general contractor in the construction phase by directing, controlling and coordinating the work of multiple contractors who were formerly subcontractors under the traditional system. The CM performs another integrating role by maintaining the schedule and project information system for the design and construction phases. When design and construction take place at the same time, close coordination between the design and construction phases is essential.

One of the basic conceptual features of the role of the CM and his relationship with the other participants is that it is professional in nature. The CM is not selected solely on price, but also on his qualifications and on his potential for producing a quality structure in an economical and timely fashion. In the system's purest form, the CM has no financial interest in the construction. His only contractual relationship is with the owner or project manager, and this is for the professional services rendered. Thus, the CM has nothing to gain and stands only to lose in allowing less than top quality performance by the multiple contractors who perform the actual construction. Like the traditional general contractor the CM serves as the principle constructor. However, the "arm's length" relationship that characterizes the owner/project manager-general contractor dealing does not exist under the CM system.

The CM is an agent of the owner/project manager, and thus be becomes a member of the professional team that consists of the owner, project manager, A-E and now the CM. This professional relationship is conceptualized in Fig. 4.2.

The professional status of the CM has another positive aspect in that it should provide for more effective application of management techniques and tools in managing the project, and in providing sound information to the project manager. Management tools and techniques would include network diagramming like Critical Path Method (CPM) and computerized cost control and information systems. There are four reasons behind this proposition:

(1) The CM, being on the owner's team, will structure the information and control system with the owner's needs in mind. The general



Source: W. B. Foxhall, Professional Construction Management and Project Administration, Architectural Record and the American Institute of Architects, 1972.

Fig. 4.2. Professional Team Concept.

contractor's control systems are strictly for his internal management and information,

(2) Since the CM's management capabilities are a prerequisite for selection, the project manager will be able to pick one with an expertise in this field,

(3) The management information and control systems, are primary outputs expected of the CM rather than the secondary nature of required CPM's and schedules from the general contractor. Therefore, it is only logical that the general contractor will do only the minimum amount of work to satisfy the project manager's information requirements, and a submitted CPM or schedule may become useless in a few days.

(4) General contractors historically have not shown interest in the application of management techniques and tools, partly due to the fragmented structure of the industry and partly due to pure negativism concerning management improvements.

4.5.5 Construction Contractors

The final major participant in the CM system is the construction contractors. The contractors are basically the subcontractors under the traditional system; however, under the prevalent CM concept, the contracts are directly between the owner/project manager and each contractor. Thus, they are no longer subcontractors, but more appropriately "multiple contractors." These contractors look to the CM as they would look to the general contractor for general supervision, scheduling and coordination. Since each of the multiple contractors is now a prime contractor, he may feel his working relationship is more formalized than when he worked as a subcontractor, and this may be a disadvantage. On the other hand, he would be assured that by bidding on a formalized basis, he would be protected from "bid shopping" or from a general contractor's pressure to reduce his bid further or lose the subcontract after the contract was awarded.

4.5.6 CM Concept In Practice

The relationship between the participants in the CM concept is best explained by the project organization diagram shown in Fig. 4.3. The project manager, CM, and A-E form the professional team. The contractor's contractural relationship is with the owner/project manager, but the

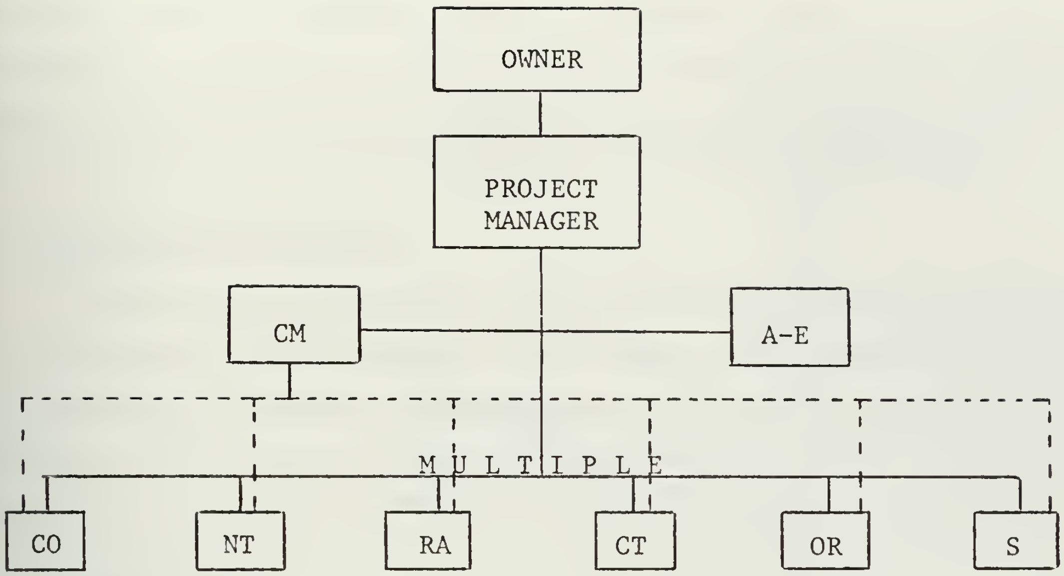


Fig. 4.3. Typical Project Organization for Use with CM Approach.

day-to-day direction, scheduling and coordinating comes from the CM. Therefore, the crux of this concept is that when the CM acts in the best interest of the owner, he is acting in his own best interest as well; in short, it is the professional approach to design and construction.

4.6 The Functions of the CM

This section will provide a list of the functions a CM performs and a discussion of each function. The reader must recognize that many of the functions are mutually interdependent, and that the manner in which one function is performed can affect the performance of other functions. Figure 4.4 is a graphic portrayal of the CM functions by project stage.

4.6.1 Market Study

One of the first jobs of the CM on a new project is to perform a market study. This study should report on the availability and cost of labor, material, and equipment in the project area for the various types of construction under consideration. The size, availability, type, skill and activity level of potential bidders in the area should also be studied. The study's purpose is to provide information on how the local construction market will affect the owner's project. This is one of the most crucial inputs the CM makes, and is one of the most neglected aspects in the traditional approach to design and construction.

4.6.2 Constructability

The CM begins from the very start of a project by providing the A-E with construction economy inputs. Even when the architect is conceptualizing the basic form of the structure, the CM should be informing him of the time, cost, and constructability consequences he is creating. From conceptualizing to design development to final design, the CM should continually be providing the A-E with comments on construction inefficiencies that are latent in the designs. The CM not only identifies these problem areas, but he also produces alternative recommendations on how to eliminate these potential problems before they become a part of the final plans and later a part of a construction contract. This function of the CM makes it clear

CM'S DUTIES / PROJECT PHASE	Predesign	Conceptual and Design Development	Final Design	Advertise, Bid, and Award	Construction	Occupancy
1. Market Study	✓					
2. Construction Economy Inputs		✓	✓			
3. Estimating		✓	✓			
4. Packaging Recommendations			✓			
5. Scheduling and Management Information		✓	✓	✓	✓	✓
6. Prevention of Omissions and Suplication		✓	✓			
7. Long Lead Materials		✓	✓			
8. Potential Bidder Identification				✓		
9. Bidder Information Source				✓		
10. Advertise, Bid and Award (optional)				✓		
11. Cost Control		✓	✓	✓	✓	
12. Contractor Capability Survey				✓		
13. Temporary and Common Use Facilities					✓	
14. Direct Schedule and Coordinate Contractors					✓	
15. Quality Control					✓	
16. Progress Payment Review					✓	
17. Change Order Requests					✓	
18. Shop Drawing/Submittal Review					✓	
19. Safety					✓	
20. Final Inspection/Punch List					✓	
21. Occupancy Plan						✓

Fig. 4.4. CM's Duties/Project Phase.

why the CM is required at such an early stage in the design, since the major design decisions are made early. Decisions regarding the form of the structure, the structural design (steel vs. poured-in-place concrete vs. precast concrete), the building's "skin" material, the vertical transportation, etc. are all made early in the project, and their consequences in terms of the construction market, ease of construction, time to construct, and cost can be enormous. The timing of these inputs should be continuous and not just at rigid intervals, such as 30 percent design, 60 percent design, etc. On many projects the communication is so continuous that the CM has a man in the A-E's office during the design phase.

4.6.3 Estimating

The CM usually performs all the estimating for the project. This function must go hand in hand with the constructability input function, since consequences of certain design decisions can only be measured in terms of cost. The CM has assumed the estimating function from the A-E, because the CM is closer to the actual cost by field experience. He knows construction and the local market, which should give him a better idea about current labor rates and productivity, prevailing material prices, and equipment costs and productivity. The skills required range from broad conceptual estimating abilities for application early in the project, to detailed quantity take off skills for throughout the design.

4.6.4 Packaging Recommendations

The CM must recommend the manner of dividing the design into separate contract packages to permit phasing construction with the design. There are many considerations involved in the packaging decision. The more important ones are:

(a) natural and practical lines of severability (i.e., electrical, mechanical, etc.)

(b) sequencing effectiveness with design and other contract packages

(c) access and availability constraints

(d) total time for completion

(e) construction market conditions.[8]

The contents and timing of the package will have a significant effect on (1) which contractors will bid on the that portion of the job, and (2) the degree of competition among the contractors. Quality packaging recommendations can thus have a tremendous impact on total project cost.

4.6.5 Scheduling and Management Information

The CM is responsible for developing the schedule for the entire design/construction process, usually by a computerized CPM program. Due to the overlapping of design and construction and the formal contractural relationships that exist between the owner and the multiple contractors, close coordination is required. Thus, the CPM must be frequently updated and used throughout the project. The computerized versions of CPM allow use of this network scheduling techniques once considered too cumbersome for practical use.[9] The CM also maintains the project management information system. This computerized system supplies information concerning the schedule, costs and financing. The system is used by all the participants in the design/construct process through a system of sorts which tailors the outputs for the various hierarchies of the owner/project manager, A-E, CM or contractor. Each one requires different types of information:

(1) The A-E may need design schedules and estimated costs,

(2) The project manager may need information on financing requirements and schedule milestone dates,

(3) The multiple contractors may need information on their schedule, and

(4) The CM may need overall schedule data and cost information for budget control.

The CM makes the schedules and maintains the management information system for the use of all the participants, not solely for himself or for the multiple contractors.

4.6.6 Prevention of Omissions and Duplication

Another function of the CM is to prevent omissions in the design and duplications between the contract packages through a thorough review of the designer's products - contract documents, plans and specifications.

4.6.7 Long Lead Materials

It is inevitable that some items on the project will require a long lead time for procurement. The CM must identify these items early in the design stage, and recommend a strategy for procuring them so the project will not be delayed. Procurement is usually accomplished by the owner buying the material or equipment himself and supplying the contractor with it when it is to be installed, or by awarding the contract for its installation at an early date so the contractor can be procuring the lead-time item.

4.6.8 Potential Bidder Identification

Depending on the constraints involved, the CM may or may not participate in the prequalification of bidders. On public jobs, prequalification is prohibited. In any case, the CM should identify high quality contractors to invite to bid on certain contract packages, instead of solely leaving the function up to a clerk in the project manager's contract office who may be using an out-of-date bidder's list.

4.6.9 Bidder Information Source

The CM acts as the information source for potential bidders on each contract. He acts in this capacity by answering specific questions posed by bidders, by showing bidders the job site, and by holding prebid conferences for all interested bidders. The prebid conferences also provide for a two-way flow of information. Not only does the bidder receive information which reduces the uncertainty surrounding his bid, but the CM gains further value engineering information from which changes to the plans and specifications can be made. In many cases, the changes can be made and addenda issued to all potential bidders prior to bid opening on that

particular contract. Value engineering suggestions should be more numerous prior to bidding under the CM system as opposed to the traditional system. The prebid conferences are held for each functional portion of the work and the contractors participating will actually be performing the work rather than the general contractor, who is acting as a broker for the bulk of the job.

4.6.10 Advertise, Bid and Award

Sometimes the CM actually advertises, takes bids or negotiates and awards the contracts to the multiple contractors. It is more prevalent for the CM to do this on private work, where the CM has guaranteed the owner a project ceiling price and/or where the owner has little or no in-house facilities staff. On most public work the governmental agencies, who are the owners in this case, are not permitted to allow the CM to perform this function. In some cases though, the CM still performs nearly all these functions with the public client's governing body merely approving each contract. This is usually the case where the owner has little or no engineering capability.[10] In a governmental bidding situation, the requirements concerning bidding and contracts are quite numerous, detailed and frequently changing. The knowledge required for this is quite extraneous to the main purpose that a CM is hired - construction knowhow. Thus, in a governmental setting the contracting responsibility is best left to the owner's project manager organization.

4.6.11 Cost Control

It has already been noted that the CM performs the estimating function, but estimating in itself is not cost control. Estimating a project is often just the first step of cost control. Cost control includes measures to ensure the intended facility is constructed within the budgeted amount for the project.

One approach a CM often employs is that at an early stage the design is estimated for a high and low cost of each functional system or potential contract (i.e., excavation, foundation, structure, mechanical,

electrical, etc.). A sum of the mean values for each category would equal the most likely estimate, and the sum of the high values would equal the maximum estimated cost; thus, the maximum estimated cost plus the contingency allowance becomes a basis for the project budget. As design proceeds, the high and low figures may be altered, but the summation of the high estimates must not exceed the budget. As bids are taken on each contract, the high estimate serves as a control amount. If the low bid on a contract exceeds the high estimate, the bid can be:

(1) rejected, that segment redesigned and rebid;

(2) accepted, with the overrun being spread over remaining margins from other segments already bid that were below the high estimate;

(3) accepted, with the overrun coming from the project contingency allowance.[11]

Figure 4.5 is an illustration of how this process works. The high bids in Contracts C and E require different approaches. The problem in C can be absorbed in the margin left by A and B quite easily. But the contract E bid endangers the project budget, so it must be redesigned and rebid. Thus, the function of cost control permits the undertaking of a project without having a firm bid on the entire job. Each segments' allocation is kept in perspective, thus minimizing the risk of overrunning the budget before all the contracts are awarded.

4.6.12 Contractor Capability Survey

Most construction contracts require a contractor to have the assets and capability to perform the work on which he is bidding. Most project managers reserve the right to inspect a contractor's facilities and make this determination. The CM working as a professional has the construction expertise to make this survey of a low bidder's assets and assist the project manager in determining his capabilities.

4.6.13 Temporary and Common Use Facilities

The permanent construction as defined by the plans and specifications is usually divisible into logical segments which can be developed

System	Estimate		Lowest	Gap	Cumulative	Cumulative Percent
	Low	High	Bid		Gap	of Job
A	1.00	1.25	1.05	-0.20		5
B	1.50	1.75	1.50	-0.25	-0.45	12
C	2.00	2.50	2.60	+0.10	-0.35	20
D	3.25	4.00	3.80	-0.20	-0.55	38
E	2.25	2.75	4.00	+1.25	+0.70	50
	10.00	12.25	12.95			

Source: Foxhall, W. B., Professional Construction Management and Project Administration, Architectural Record and American Institute of Architects, 1972, p.14.

Fig. 4.5. CM Cost Control Example.

into separate contracts. However, the provision of temporary and common use facilities at the job site has customarily been the responsibility of general contractors. Under this system, the CM is logically given the responsibility of providing these facilities, which include such items as the construction perimeter fence, the toilet facilities, and field offices, the temporary power and water, etc. The CM provides these facilities with his own forces or ensures they are procured by contract.

4.6.14 Direct, Schedule and Coordinate Contractors

At the job site, the CM maintains a field organization that is actively involved in the work to ensure the smooth and timely operation of the multiple contractors. The CM maintains communication with each contractor concerning the start and completion times of his various tasks. He coordinates and oversees the work of different contractors when their respective tasks are closely interrelated. The more contracts there are on a project, the more critical this coordination becomes. Under the traditional approach these functions are the province of the general contractor, and in his absence under this system, the CM assumes the role. Some people assert that the CM does not provide project direction in a fashion similar to the general contractor, but in practice the CM is looked to actively supervise at the job site. The multiple contractors are products of a subcontractor heritage, and as such, tend to lean heavily on the headman of the site for direction.[12] Since the CM is filling this role, he is looked to for direction, and if the project is to be successful he had better be able to provide it.

4.6.15 Quality Control

As the CM system has emerged, the CM is generally being given the responsibility for quality control. However, many existing CM configurations still leave quality control to the architect or owner/project manager, or even a combination of the two. Also, in some cases quality control is shared by architect, owner, and CM. This joint responsibility situation usually exists where there is no organized approach to quality control. Nevertheless, the CM is the logical choice for quality control, because he knows construction practices. He is working for the owner as a professional

who has no financial interest in the project, and thus stands to lose his "hard-earned" reputation if contractors "cut corners" on quality. Due to his professional relationship with the owner, it is conceivable that quality control could be provided by the same personnel who direct and coordinate the multiple contractors.

4.6.16 Progress Payments

The CM checks the payment requests from the various contractors to ensure that they have completed the work they have claimed for monthly reimbursement. The CM may use the multiple contractor's CPM schedule or his schedule of work quantities and corresponding prices to determine the validity of his payment request. The CM passes his recommendations to the owner's representative for authorization and payment, or for resolution if the CM and contractor cannot reach agreement.

4.6.17 Change Orders

Regardless of where a valid change order may originate, the CM prepares an estimate for the change since he has provided all the project estimating. The CM also may negotiate with a multiple contractor to reach a fair and reasonable price. However, when the contracts exist directly between owner and contractor, the final approval of any change order rests with the owner/project manager.

4.6.18 Shop Drawing and Submittal Reviews

The CM serves as the first stage in the review of shop drawings and submittals. As a general contractor relays the shop drawings and submittals from the subcontractors to the project manager with some eventually passing to the A-E, the CM performs this same function. However, as a professional working for the owner/project manager, he can screen the obviously unacceptable ones and return them for resubmission. Since he has worked on the design he may understand the designer's intent more clearly and this knowledge improves his ability to screen these submissions.

4.6.19 Safety

Even though each contractor is responsible for the safety of his own personnel, the CM prepares an overall safety program and enforces accident prevention requirements on the job site.

4.6.20 Final Inspection/Punch List

Contractors traditionally tend to request final inspections before numerous contract discrepancies are corrected. Through his inspection program, the CM seeks to clear up nearly all of the "loose ends" before the final inspection. After this preparation phase, the CM notifies the project manager that a particular contract is ready for final inspection. The inspection is made and a "punch list" of discrepancies is prepared. The CM uses this list to ensure that the contractor completes his work before recommending final payment on the contract.

4.6.21 Occupancy Plan

The CM may be asked to prepare the occupancy plan for the completed facility. The complexity of an occupancy plan is often directly proportional to the complexity of the construction project. Frequently, occupancy time can be optimized when closely coordinated with construction, and thus the occupancy plan is included in the network planning diagram for the entire project.

4.6.22 The CM and the Classic General Contractor

Many of the specific functions of the CM are the same as the classic general contractor; however, the CM's professional relationship to the owner makes it possible for him

(1) to carry this construction expertise back into the design of the project,

(2) to integrate the design and construction phases through a master time schedule and cost control system, and

(3) to begin construction at an earlier date than would be possible through a traditional arrangement.[13]

4.7 The Nature and Organization of CM's

4.7.1 Types of CM Firms

Since the CM system is still a fairly new approach to construction, the nature and background of the firms that hold themselves out as CM's are quite varied. CM firms are usually the derivatives of a design or construction background. The background of these CM's affects the way they view their roles and the organization created to accomplish their tasks.

4.7.1.1 A-E Oriented CM's

Many firms in the CM arena are the outgrowths or products of architectural or consulting engineering firms. Since the CM role is a professional one, the architects and engineers stress that this is a style with which they are quite familiar. They also stress that they understand how to work with design professionals. They point to the fact that they are experienced in conceptual estimating or estimating building systems. Their services strongly emphasize the design phase of the project, and indicate that poor management by general contractors has led to CM in the first place. A-E oriented CM's generally promote CM in its purest form, where the CM assumes no financial risk whatsoever in the project.

4.7.1.2 General Contractor Oriented CM's

Many other CM's have developed in general contracting firms. The strongest assets of these CM's are their intimate knowledge of construction methods and materials, and their ability to manage prime or subcontractors. These general contractor oriented CM's are much more likely to accept alternate arrangements to the "purist" concept of CM whereby the CM begins to share in the financial risk of the project by guaranteeing a maximum price. They guarantee the project cost because they have the bonding capacity as a general contractor to establish a maximum dollar amount on which many owners insist, and which most A-E oriented CM's cannot or will not provide.

In researching the topic, the general contractor type CM seemed to have more of a continuing dialogue with the project A-E than the design

oriented CM. The latter CM seemed to hold the design perogative of the A-E in much higher esteem and to honor the A-E's traditional dominance over the design phase. As a result of this traditional approach, this CM seemed to get involved with the design phase at specified intervals, and at these times would recommend cost alternatives only when the current estimate exceeded the budget. This "satisficing" relationship reduces much of the potential of the CM system. The general contractor CM's interviewed seemed to continually interject themselves into the design phase, providing critical review of design work and supplying cost alternatives. It should be noted that these general contractor oriented CM's were the products of very large and successful construction companies, whose staffs consisted of highly professional engineers and construction personnel. Thus, the notions concerning contractors' uncertainty in dealing with the design phase may prove true for the bulk of the nation's general contractors who run much smaller operations.

4.7.1.3 Field Orientation of the CM

In the construction phase, the general contractor type CM's assume a more active role. One A-E oriented CM said that they tried to overcome this lack of field orientation by producing the most "perfect" set of plans and specifications possible. Therefore, problem-solving on the site is minimized. This writer feels that this approach operates under one of the basic misconceptions that the traditional system operates, and that is a perfect set of design documents can be produced and also be followed in building a job. However, these A-E oriented firms do try to solve their lack of construction experience by hiring veteran construction superintendents to monitor the on-site construction work, or by engaging a general contractor as one of the multiple contractors.

4.7.1.4 The Organization of CM Firms

The organizational strategies of CM firms are developed to deal with both the design and the construction phases. The CM firm usually assigns

responsibility for overseeing the project to one of its principal members. However, the bulk of the responsibility is assigned to the construction executive, who works on the design and construction phases on a full time basis. The title of this construction executive becomes quite confusing at this point. He is referred to as Construction Manager, Project Manager, Construction Engineer, Contract Manager, Project Superintendent, Construction Superintendent, and so on. The titles become even more confusing as one studies hierarchical levels in various CM organizations. These titles are found in use in different levels in different organizations. Figures 4.6 through 4.12 show some example organizational structures used by CM firms. Contractor-oriented CM's tend to have more sophisticated field organization than the A-E oriented CM's. In one case, the writer found an A-E type CM firm which is liability conscious and weak on field experience. They use the technique of including field supervision in one of the multiple contracts being bid on by general contractors. In other cases this firm retains local general contracting firms to provide field supervision. In this writer's opinion, this is a suboptimal approach to delivery of CM services. The more continuity of personnel participating in both the design and construction phases, the more benefits are to be derived from the CM approach. However, as CM becomes more institutionalized, there will be a real danger of some CM personnel working only in the design phase and others only in the construction phase. This will dilute some of the effectiveness of the CM. In summary, the organization a CM firm uses in accomplishing a project is a function of the owner's requirements, the size of the project, the resources of the CM, and the nature of the firm.

As the CM system becomes more widely used, laws in various states will probably be instituted to govern the practice of CM. A-E and contractor oriented firms will be competing in terms of project performance to gain the support of owners, and in politics to gain the support of legislators.

4.8 Manner in Which CM Services Are Delivered

The CM delivers his services in three ways:

(1) as a consultant

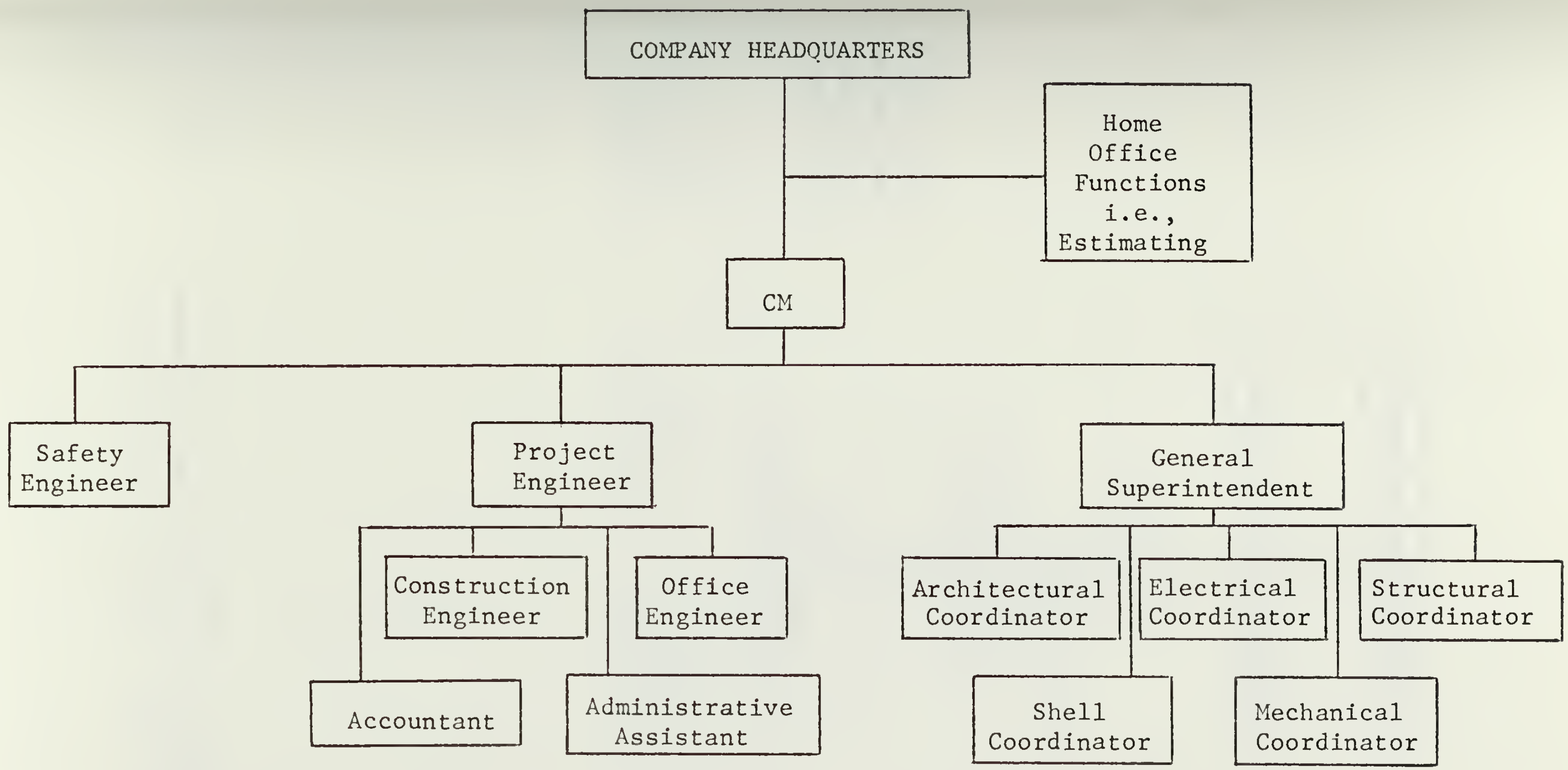


Fig. 4.6. CM Organization of Gilbane Building Company on Smithsonian Institute's Air and Space Museum, Washington, D.C. (GSA Project).

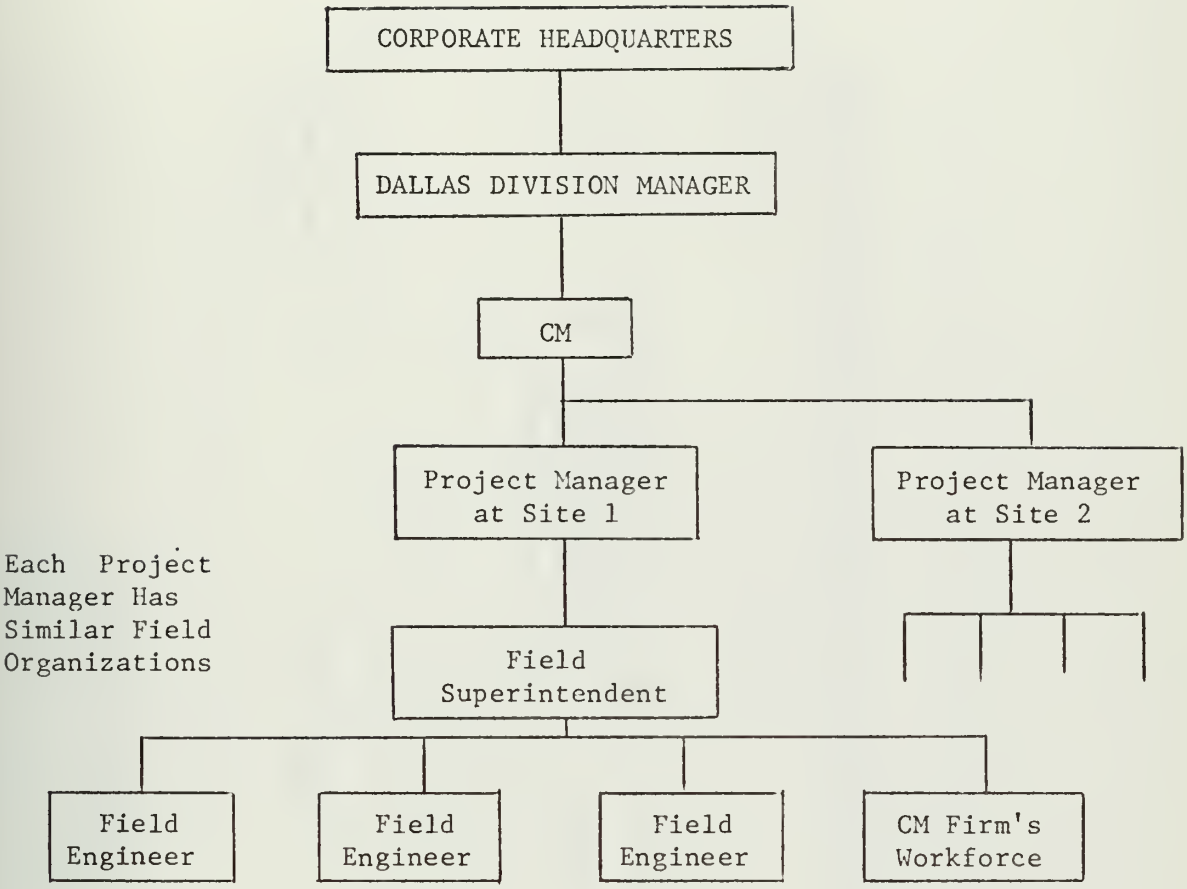


Fig. 4.7. CM Organization of Robert E. McKee Construction Company on Two Project Site for Dallas Junior College District, Dallas, Texas (HEW Project).

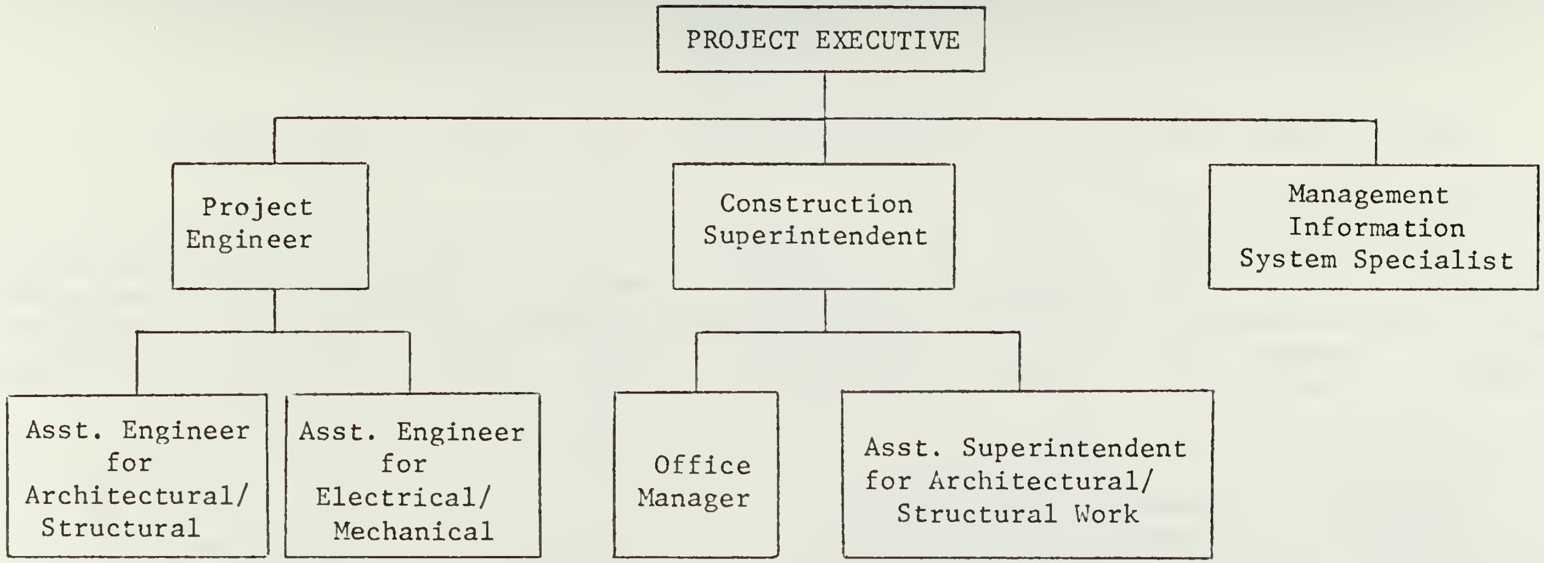
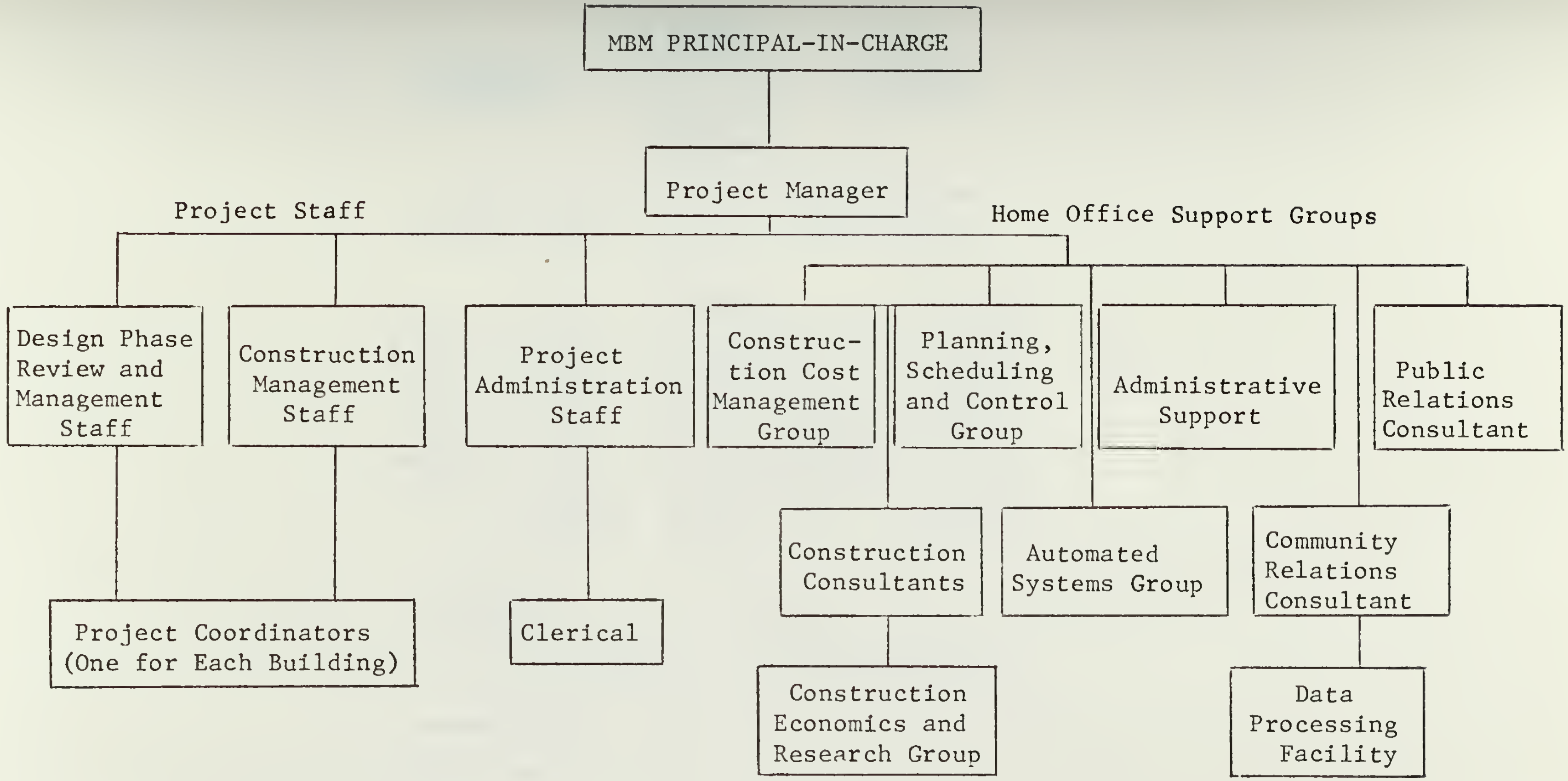
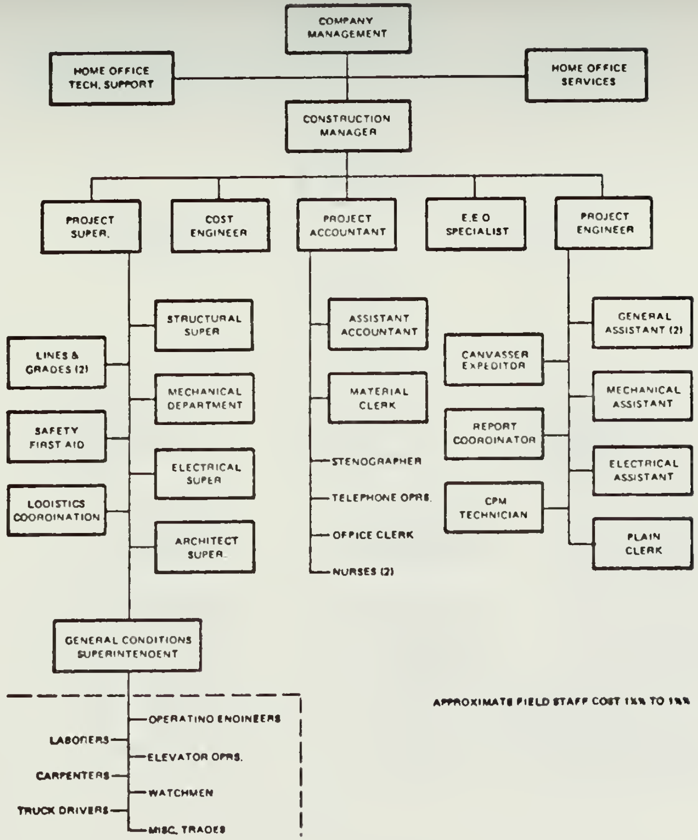


Fig. 4.8. CM Organization of Turner Construction Company for Federal Home Loan Bank, Washington, D.C. (GSA Project).



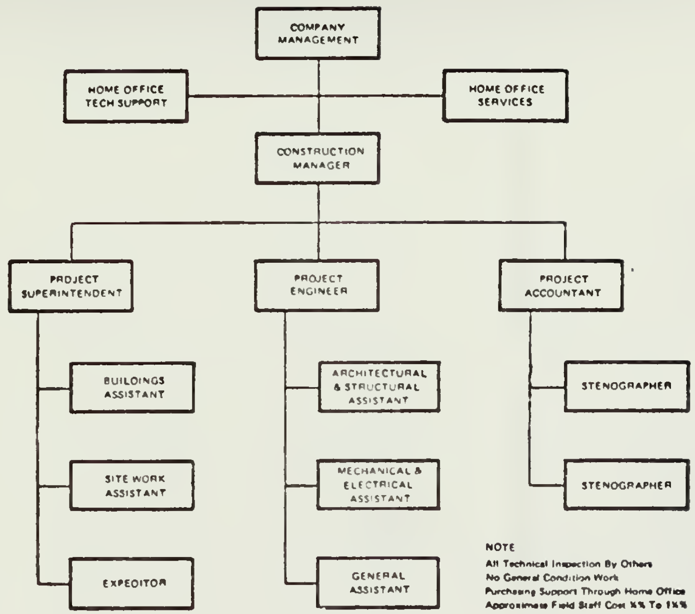
Source: W. B. Foxhall, Professional Construction Management and Project Administration, Architectural Record and the American Institute of Architects, 1972.

Fig. 4.9. CM and PM Organization of McKee-Berger-Mansuato for University of Massachusetts at Boston.



Source: Association of General Contractors Construction Management Handbook.

Fig. 4.10. Construction Management Organization: Many Prime Contracts.



Source: Association of General Contractors Construction Management Handbook.

Fig. 4.11. Construction Management Organization: Few Prime Contracts.

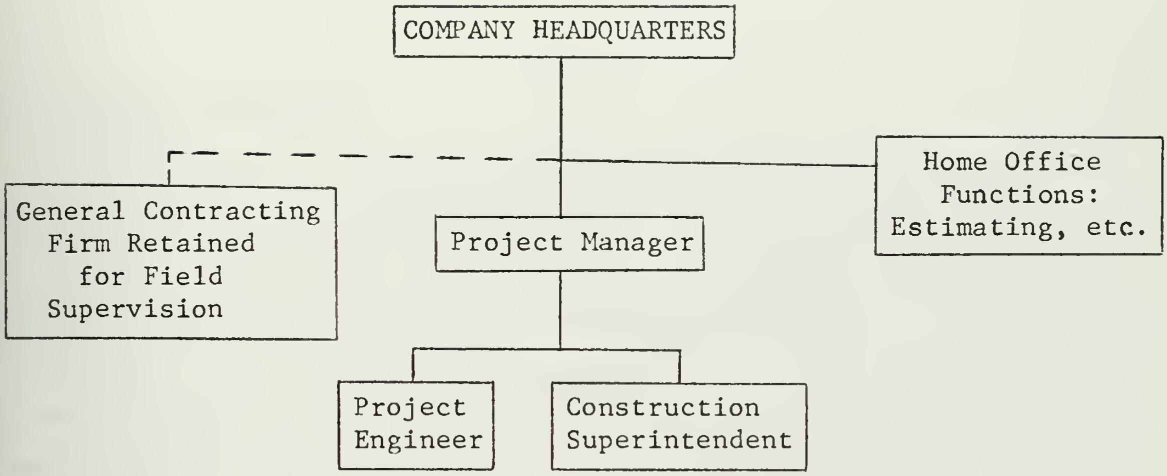


Fig. 4.12. CM Organizational Strategy for an A-E Oriented CM Firm.

(2) as a manager

(3) as a general contractor

4.8.1 CM As a Consultant

The consultant approach is practiced primarily by A-E oriented CM's who are strongly liability conscious. These CM's tend to concentrate their efforts in the design phase, and try to limit their liability by restricting their participation in the construction phase to such activities as "observing" and "surveillance" of contractors. Even though the consultant method appears to be a poor method of providing effective CM services, it may be used to enlist construction consulting services for a specific task on a traditional project such as a difficult estimating problem or a design requiring some limited construction technology input.

4.8.2 CM As a Manager

The next approach is the manager technique, in which the CM is actively involved in all phases of the project. Under this approach the CM is working as a professional for the owner's project manager, and as such, acts as his agent in directing, coordinating, inspecting, and controlling the multiple contractors. The CM does not bear any financial risk under this system, and all construction contracts are between the owner and contractors. This has been referred to as CM in its purest form. The CM can act in the owner's best interest without incurring financial losses to his own firm.

The contractural arrangements between the owner and CM under the first two delivery techniques are on a fee basis similar to the way architects and engineers are retained. This underscores the professional nature of the services provided.

4.8.3 CM As a Modified General Contractor

The third delivery technique is the general contractor approach (not to be confused with a general contractor type CM, which describes the CM's background). Under this approach the CM is actually a general contracting firm the owner hires at the beginning of the project along with

the A-E to work in the design phase and to actually perform the construction with his own forces and subcontractors. When the design becomes sufficiently defined, this CM will usually negotiate a contract with the owner with construction not to exceed a guaranteed maximum price. This approach is less professional, because the CM now stands to lose if the "guaranteed max" is not met. The CM's financial stake in the project may have a significant influence on his decision making capability, but some owners insist on the protection of a maximum construction cost. CM's who operate under this approach quite frankly admit that the project estimates are padded to protect the CM's risk exposure, and that the total project cost is usually higher under this "guaranteed max" approach that purer CM approaches described earlier.

This presentation on the delivery techniques corresponding to contractual arrangements has been simplified. Each CM and each owner who retains a CM employ different degrees and combinations of the described methods to accomplish a project, but these are the rough conceptual categories into which CM's are placed.

4.9 Resources Available from CM's

There are five areas of expertise that each CM should be able to provide the owner/project manager for whom he is working. These are:

(1) Construction expertise

(2) Estimating expertise

(3) Design expertise

(4) Management expertise

(5) Geographical expertise

4.9.1 Construction Expertise

Above all the CM must understand construction: its methods, materials, processes, practices, customs, structure and the industry in general. He must have the knowledge of a competent general contractor to effectively contribute construction technology and alternative solutions

to the design phase. If a CM does not fully understand the construction methods, labor and equipment required to place the material as the A-E is drawing on the plans, then he is not as valuable to the owner/project manager. The CM who possesses this important construction "knowhow" resource should be able to apply it by critically reviewing the designer's work, and in turn, providing the A-E with potential construction efficiencies and alternative methods that he could use to revise and refine his design. These would reduce costs and develop a structure more suited to the owner's requirements.

4.9.2 Estimating Expertise

The CM must also have a broad range of estimating resources. These resources should include the ability to estimate construction costs from a set of conceptual drawings, as well as detailed "quantity take-off" estimating capability. The skills of a sound cost estimator should be supplemented with a data base of accurate and current costs for building subsystems as well as detailed items of work. Many CM's have tools such as computer assisted retreival capabilities, to quickly apply the data base to estimating the job. Regardless of methods and tools used, frequent updates to the estimate are required to closely control potential costs in the design phase and to eliminate excessive design reworking. The estimating expertise of the CM must also include common sense in the application of estimates to designs. Each construction project is unique in some way, and the estimator must have the flexibility to realize this. He cannot mechanically apply quantities to unit costs without considering the peculiarities of the task to be performed and expect to come up with relevant estimates.[14]

4.9.3 Design Expertise

The CM should also have expertise in architectural and engineering design. He need not be a designer, but he should thoroughly understand the process an A-E goes through in designing a structure. He must understand design procedures to be able to interface construction technology, market studies, and estimating inputs with the A-E's work in a timely and

effective manner. The experience of many CM's has been that they are initially resented by A-E's. Usually the A-E's begin to work well with the CM's when they realize that the CM has a worthwhile service to offer.[15] This may take one or two projects in which the designer and CM work together. Thus, design expertise by the CM serves to make his construction input more effective, and hopefully, the CM's professional nonadversary approach develops into a good working relation with architectural and engineering firms.

4.9.4 Management Expertise

The CM must be adept in the application of management techniques, such as network planning and scheduling and management information systems. Techniques such as CPM have not been used as a working scheduling tool by general contractors under traditional operations.[16] However, CM's use computerized CPM's and management information systems extensively, because the overlapping of design and construction (fast tracking) and the use of multiple contractors requires closer project coordination and control. Also, the owner/project manager plays a more active role in project control, and he too must have more information than he would under traditional circumstances.

The CM must also have human resource management skills. Since the contracts are between the owner/project manager and the multiple contractors, the CM may not have as much absolute authority as general contractors have over subcontractors. He must be able to work with all participants, professional and blue collar alike.

The owner/project manager forsakes the traditional approach with its lump sum bid price to use a CM, because he feels that in the final analysis his new facility will be produced at the lowest possible cost and within the shortest time. The CM then should have enough managerial capability to effectively use the technical and human resources of the participants to produce the desired end result.

4.9.5 Geographical Expertise

A critical resource which the CM must possess and which may easily be overlooked is the knowledge of the local construction market at the project site. Ignorance of the availability and cost of labor, material and equipment, and peculiarities of the construction industry in the project area can lead to ineffectual or even disasterous decision making. One of the goals of the CM system is effective employment of all resources in the execution of the project. As has been stated previously, the construction industry is a heterogeneous, fragmented, locally sensitive industry. Thus, the construction economics and peculiarities of the project area must be known. The CM may find it more economical in a project area to use casted-in-place concrete, since the nearest prestressed plant is 300 miles away. He may find that the mechanical engineer feels that pneumatic air conditioning controls are the most efficient, but local contractors only have experience in installing electrical ones. He may find that no contractors in the area have tower cranes, one has a 300 ton crane, and six have cranes in the 100-150 ton range. The only three masonry contractors in the area are working at full capacity and will be for the next six to eight months. This kind of information can influence the basic as well as the detailed design decisions which must be made to reduce the project's price and time schedule.

4.10 Cost of the CM System

There are a number of compensation arrangements under which CM's work.

4.10.1 Fixed Fee

Most CM's work for a fixed fee or some variation of the fixed fee system. This system is similar to that used by design professionals in the delivery of their services, in that the fee is based on a percentage of the estimated project cost or the estimated staff and overhead costs of the CM plus a reasonable profit. The fixed fee is paid to the CM as long as he carries out his contractual obligations, regardless of the cost and time performance of the construction. This underlines the professional

approach to delivery of CM services, since the CM bears no financial risk in the project.

4.10.2 Fixed Fee and Reimbursables

One common variation of the fixed fee system is to allow certain expenses of the CM to be reimbursable because of the uncertainty of the extent of these expenses. A-E's historically have used reimbursable expenses for such things as required travel and per diem expenses associated with the project. The CM's reimbursable category on the other hand, seems to be filled with a larger variety of potential expenses. Not only are travel and per diem included, but also items such as the cost of temporary and common use facilities, and additional job site staff above the staffing level included in the fixed fee. Unlike A-E contracts, the reimbursable portion of the CM's fee can be much larger than the fixed portion of his fee. However, many of these costs were traditionally paid by general contractors so prime contract work will be reduced. When the CM negotiates his contract, even before design has begun, there are many uncertainties about the construction phase. The temporary and common use facilities which are extensive on a large project are totally undefined, and thus it is impossible to include them in a fixed fee. The job site staff is also an unknown variable, since its size and make-up will be a function of the design, the number of contractors involved, and the "tightness" of the project time schedule. Most owners/project managers feel that to maintain the "risk-free," professional posture of the CM, they must allow him to cover his uncertain requirements through reimbursable expenses.[17] Regardless, the owner/project manager must maintain some controls over these reimbursable categories to ensure that they are used in a prudent and resourceful manner.

4.10.3 Guaranteed Maximum Price Incentives

Another way that CM's are compensated is through incentive bonuses. These are usually tied to projects in which the CM has guaranteed a maximum price in an effort to get the project to come in substantially below the ceiling figure. Under this type of arrangement, the owner and CM usually share in the difference between the actual price and the "guaranteed max"

when the project is completed in the "black." The theory behind using the guaranteed maximum price and associated incentives is that the CM has an interest in minimizing the project cost, and as a result will maximize the return to the owner as well as to himself. Opponents of the guaranteed maximum price counter that the project cost will be greater and quality reduced when not using the "pure" professional approach to CM. They claim that the CM will sufficiently pad estimates to obtain a high ceiling price to ensure self-protection against financial loss, and to maximize the chance of collecting incentive bonuses. If the "guaranteed max" is in danger of being exceeded, then the CM may make decisions to protect his own financial interests which can affect the quality of the job.

4.10.4 CM System Project Cost

Most owners/project managers are concerned about how the project cost under CM relates to project cost under the traditional system. The added cost of the CM must be compensated for in savings elsewhere in the project. Figure 4.13 shows the cost structure of a traditional project vs. a CM project. The traditional project costs are made up of the A-E's contract, the general contractor's contract, the project manager's administration cost, and perhaps some miscellaneous engineering services. The cost of the general contractor is segmented between the cost of the subcontractors, the general contractor's fee for managing them, the cost of labor, material and equipment for the work done by the general's own forces and his profit, overhead, and contingency allowance. Under the CM system the construction work is still done primarily by subcontractors, except they are now called multiple or prime contractors, and there may be more of them since the general's in-house work must now be done by one or more additional contractors. However, it is very likely that the multiple contractors may charge the project manager less than a general contractor because

(1) the contractor knows his price will not be "beaten down" further,

(2) bidding close to when work begins on that portion of the work reduces economic uncertainties and

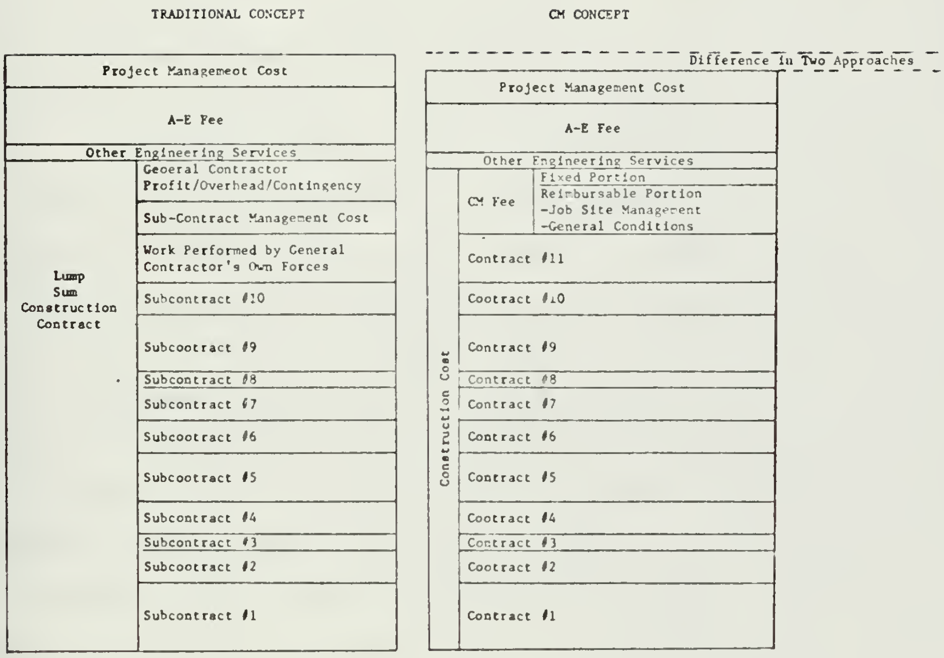


Fig. 4.13. Project Cost Structure.

(3) since construction technology and market awareness were "cranked" into the design of the project, the plans should be less ambiguous and more construction-efficient.

The cost of the contractors should be the same as it was to the general unless the system introduced uncertainties the multiple contractors compensate for by upping their contingencies. The CM's cost replaces the general's profit, overhead, subcontractor management cost, and contingency allowance. On a project these may run 6-8 percent.[18] This was validated by GSA's experience which is covered in Chapter 6. The CM's fee depends largely on the extent of the services required of him. Since the concept is so new there are no standards, but CM fees commonly range from 4 percent to 6 percent. Undoubtedly the CM takes the estimating load and some inspection responsibilities off the A-E. Therefore, the A-E's fee should be correspondingly reduced even though this is a highly unpopular notion. The use of the professional CM approach may also reduce the field administration expense of the project manager, since the CM performs the inspection function. However, there may be corresponding increases in legal, office, and paperwork expenses, since there will be numerous construction contracts rather than one under the traditional method. Many qualitative judgments must be made in trying to quantitatively analyze the cost of using a CM system over using the traditional system. At best when considering project design, construction, and management costs without regard to project delivery time or project quality, comparisons such as the Project Cost Structures shown in Fig. 4.13 can serve as a guideline for analysis.

4.11 CM Sensitivity

There are a number of factors to which the CM system is sensitive that must be considered for the successful application of this technique. They are as follows:

(1) Cash Flow. This factor is critical when the overlapping of the design and construction phases is planned. The owner must have funds readily available to begin to commit himself to construction contracts very early in the project life.[19]

(2) Decision Making. The CM must have firm, prompt decisions from the owner/project manager on various aspects of the project. As stated earlier, the CM system requires greater participation from the owner, so the owner must have the organization to interface with the CM. To ignore this requirement may render the CM ineffectual.

(3) Information. Due to the overlapping of design and construction and the complexity of the contractural relationships with numerous "prime" contractors on site, the steady and effective flow of information is essential to project success. Contractors must know when to be on the job and when to coordinate with other contractors. For example, they need to know when to expect submittal approvals to be returned. Owners/project managers need to have cost and financial information. A-E's need to know the design deadlines for the various contracts and when to expect the estimates from the CM. The CM needs information from all sources to update the master schedule. It is obvious that under the CM system, where design and construction are integrated and active management of the project is increased to improve project performance, that information flow becomes much more critical.

4.12 Project Risk Structure

Under the traditional approach to construction, the risk structure has been fairly well defined through the contractual documents and the court system. The general contractor has traditionally borne the risk for:

(1) Misreading and misinterpreting the plans and specifications

(2) Bid calculation errors

(3) Material availability and price stability

(4) Labor availability and price stability

(5) Productivity fluctuations, including labor problems

(6) Weather

(7) Project safety

(8) Environmental compliance for construction operations

(9) Scheduling and coordinating subcontractors.

The owner/project manager has usually assumed the risk for:

(1) Design omissions and mistakes

(2) Changes required by the owner

(3) Unforeseen site conditions.

Through his lump-sum bid, the contractor provided owners/project managers with what they feel is a low risk exposure. For the large amount of risk the contractor undertakes, he compensates himself with a high mark-up in his bid. The old business correlation that "the higher potential risk, the higher the potential return" is well known to the contractor. He knows his risks are high, but he knows he stands to make a sizeable return if the job runs smoothly. In a way, the owner-contractor risk relationship also exists between contractor and subcontractor. Subcontractors whose work is in the later stages of a project and who must bid before work begins are subject to high uncertainty and high risk, and their contract mark-up compensates for this. The contractor then passes these "risk compensations" on to the owner in his contract price.

The owner's risk obligations seem small as listed, but many poor quality contractors further increase their project income through the shrewd "change order" management. Through extremely literal and "nit-picking" plans and specification interpretations, this type of contractor seeks to exploit the owner's liabilities to generate change orders and increase his own return. These contractors reduce the risk protection the owner has against contract cost increases.

In the recent inflationary cycle some contracts have used cost escalation clauses to reduce the uncertainty for which the contractors were having to charge phenomenal contingencies. These cost escalation clauses have had the effect of transferring much of the risk to the owner. To be specific, labor and material price stability, previously listed as major risks borne by the contractor, were transferred to the owner.

Under the "pure" CM system the risk structure changes, even though the owner/project manager have the same risk relationship with each multiple contractor as they did with the general contractor. On the overall project scale, the owner/project manager assumes most of the traditional general contractor's risk obligations. The main risks which must concern each owner/project manager in evaluating a shift to the CM system are labor and material availability and price stability, the implications of responsibility for overall project safety, and scheduling and coordinating multiple contractors. As the contractor correlates high risk with a high possible rate of return, the owner/project manager must also hope to achieve the likelihood of gains by assuming more risk. The returns gained by the owner/project manager may not be completely measurable. These returns may include, but are not limited to a more economical cost of construction, shorter construction time and a better quality job. These could result in quicker occupancy benefits from the service of the new facility, high user satisfaction, a hedge against the facility becoming obsolete even before completion, and a hedge against numerous user requirement changes that occur when the project life is drawn out.

If the owner/project manager assumes the greater risks under the CM system in an effort to achieve the higher returns, he can take actions which will allow him to hedge on the risk with the high returns still remaining possible. This may be done by prudent management actions such as

(1) providing in-house management of the project through a well organized project manager's organization,

(2) selecting a highly qualified CM, and

(3) providing the CM with clearly defined requirements of what he is to accomplish.

The owner/project manager may also shield himself against the risk of exceeding his budget by using the guaranteed maximum approach, but he does so at the cost of losing other benefits mentioned in Section 4.10.2

There are more risks to the owner/project manager in the CM system, and the value of the gain expected by going to the system should be

analyzed before adopting the CM approach. However, if major risks such as cost escalation are transferred from the general contractor to the owner/project manager when using the traditional approach, the risk structure becomes more similar to that under the CM concept. Also the owner/project manager, through shrewd management, can minimize his risks and still achieve the high expected value of the system.

4.13 Summary

This chapter has sought to describe the CM system from a variety of angles, and to note some of the implications associated with the CM method. The reader should leave this chapter with one main point: CM is not a panacea for all the problems of the construction business. CM is a system that seeks to use the existing resources of the construction industry to deliver construction in a more effective manner. The CM does this by interjecting construction considerations into the design phase, and assuming a supervisory role in the construction phase while maintaining a professional relationship with the owner/project manager.

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CHAPTER 5

PERFORMANCE OF TRADITIONAL NAVY SYSTEM

5.1 General

Before considering the use of one alternative approach to Navy contract construction procurement, the performance of the existing system should be analyzed. From an analysis of the existing traditional contracting and controlling methods, areas needing improvement can be identified.

Ideally, the best approach to comparing two design and construction delivery systems would be to compare a number of similar projects at similar times under similar conditions in similar localities. Unfortunately, since each construction project is unique to some extent, it is nearly impossible to find two similar projects - much less two that are alike in all aspects, not just design alone.

This chapter will seek to give some quantitative performances data and subjective comments on Navy projects procured by traditional methods. The next chapter will provide some similar data on projects done by the General Services Administration (GSA) on some of their projects accomplished under the CM approach. The reader should use extreme caution in making a direct comparison, because of the dissimilarity in the projects and the circumstances that surround them. Furthermore, the nature of the two project manager organizations, the Navy's NAVFAC and GSA's Public Building Service (PBS), are different in many aspects.

5.2 Research Method

However, if one examines the Navy's performance as it compares to its own goals, this can serve as some basis for measuring the effectiveness of the existing traditional system as used by NAVFAC. The performance data

reported in this chapter has been taken from NAVFAC computer reports that pertain to the status of projects, and from summary reports that accumulate data from projects for comparison against various NAVFAC goals.

The summaries are referred to as goal reports and the status of projects are in field execution reports. Since it is a generally accepted fact that the CM approach is more appropriate for large projects in excess of $5 million, the writer has tried to extract data for Navy projects in this price range. Since these projects are not separately summarized in NAVFAC reports, the writer surveyed all the EFD, Field Execution Reports of 30 June 1975 and identified 143 projects with budgets exceeding $4.5 million.[1] $4.5 million was chosen due to the large proportion of projects just under $5 million and since budgets tend to increase as the project progresses they seemed to be in the CM project range.

Even though all the active projects and projects completed during FY 75 were included in the report, few large projects (over $4.5 million) showed as completed. Thirty-two projects were selected that appeared to have progressed substantially to allow accurate projections to be made about their completion time and cost. Since some of the computer data appeared to be erroneous and other information not contained in the reports was required, each ROICC to which one of the thirty-two jobs was assigned was sent a letter as shown in Appendix C, requesting information. The information sought milestone and time data, bid data, change order data, and cost data. The manual technique of procuring this information limited the amount of projects which could be surveyed, and this limitation of small sample size must be considered in examining the results. The data base was further limited in that ten projects were not reported, reducing the sample size to twenty-two. On the other hand, the results may be somewhat better for the sample than for large projects on the whole, since only projects substantially constructed were selected. Problem-laden projects may have been passed over for this study, since they are not far enough along to make accurate predictions about completion data. The projects reported on are shown in Appendix D.

The accumulated data from the large projects are shown in Table 5.1. Information concerning time data, number of bidders and estimating

TABLE 5.1. LARGE PROJECT PERFORMANCE

(1) Construction Start. Award of construction contract in year corresponding to projects program year (PY).

Relationship of FY of Award to Project PY	PY and FY Same	Award in Next FY	Award Beyond Next FY	TOTAL
Number of Projects Awarded	6	14	2	22
Value of Projects Awarded	$34.3M	$104.3M	$20.9M	$159.5M
Cumulative Percentage	21%	87%	100%	--

(2) Plans and Specifications (P and S) Complete. Relationship between FY by which P and S are complete and project program year.

Relationship of FY by Which P&S Are Complete to Project PY	Within Same FY as PY	By 30 Sept. of Next FY	Beyond 30 Sept. of next FY	TOTAL
Number of Projects Where P&S Are Complete	12	3	6	21
Value of Projects Where P&S Are Complete	$76.7M	$ 17.8M	$44.2M	$138.7M
Cumulative Percentage	55%	68%	100%	--

(3) Change Orders. There were projected to be $4.7 million of change orders on 21 projects valued at $153.7 million. This corresponds to a project cost increase of 3.1 percent over the initial award amount. There was an average of 30 change orders per project.

TABLE 5.1 (cont.)

(4) Occupancy. Relationship between beneficial occupancy date and original contract completion date (CCD).

	Occupancy Takes Place			TOTAL
	Within 3 mos. of CCD	Between 3 to 6 mos. of CCD	Beyond 6 mos. of CCD	
Number of Projects	11	4	6	21
Cumulative Percentage	52%	71%	100%	--

(5) Estimating. Performance expressed as the percentage that the low bid exceeds the government estimating (under estimate) or that the low bid is below the government estimate (over estimate). For 19 projects in sample, average variance was ± 13 percent. Removing two widely deviant estimates, the average became ± 10 percent.

D I S T R I B U T I O N

Underestimate				0	Overestimate				
Over 20%	15-20%	10-15%	5-10%	0-5%	0-5%	5-10%	10-15%	15-20%	Over 20%
3	0	1	4	3	0	4	2	0	2

0

(6) Length of Design Time. Average was 14 months for 20 projects.

D I S T R I B U T I O N

Design Times (months)

	7-9	10-12	13-15	16-18	19-21	22-24	25 and up
Number of Projects	2	6	7	2	1	1	1

TABLE 5.1 (cont.)

(7) Length of Bid Time (time between completion of design and award of construction). Average was 3.5 months for 21 projects.

D I S T R I B U T I O N

Bid Time (months)

	1	2	3	4	5	6	7	8
Number of Projects	3	2	9	3	1	0	1	2

(8) Length of Construction Time. Average was 24 months for 22 projects.

D I S T R I B U T I O N

Construction Time (months)

	15 or less	16-18	19-21	22-24	25-27	28-30	31-33	34 or greater
Number of Projects	3	2	3	5	1	5	2	1

(9) Length of Total Project Time (all phases). Average was 41 months for 20 projects

D I S T R I B U T I O N

Total Project Time (months)

	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
Number of Projects	1	1	2	4	7	2	1	2

TABLE 5.1 (cont.)

(10) Number of Bidders. Average was 7 bidders/project for a total of 19 projects.

D I S T R I B U T I O N

Number of Bidders/Project

	3	4	5	6	7	8	9	10	11	12	13	20
Number of Projects	1	4	5	2	2	0	1	2	0	0	1	1

(11) Average Size of Projects in Sample Was 7.6 Million.

performance is shown in histogram form, so that the actual distributions may be seen. With this size sample, extremely high or low figures can significantly influence averages.

5.3 Quantitative Results

Table 5.2 shows a comparison of NAVFAC goals to all Navy Military Construction (MCON) projects and to the large project sample.

5.3.1 Construction Starts

One of the major goals of NAVFAC is to get as many projects as possible in one program year under contract by the last day, June 30, of the corresponding fiscal year. The reasons for this "push" to make June 30 seems to be two-fold.

(1) Once the project is under contract, the implementation phase has begun and it appears the resources allocated for the project will be sufficient to accomplish it.

(2) As noted in Chapter 3, the size of the MCON appropriation for the next program year may be dependent on how fully the funds for the current year have been used. Even though the construction appropriations do not expire, congressmen consider the ability to obligate these funds expediently important in examining new programs.

This is a very difficult goal to achieve in that the appropriations are not usually received until well into the program year, sometimes leaving only six months in which to award all the contracts. For the FY 75 MCON Program, NAVFAC awarded 80 percent of the projects and 70 percent of the total program dollar value.[2] The criterion for qualifying the total authorized project dollar value as a construction start is to award one or more contracts for at least 50 percent of the authorized amount.

Another NAVFAC goal is to start 100 percent of a MILCON program by the end of the subsequent FY after the program year. Another motive which prompts this goal, other than the two given in the preceding paragraph, is that the project authorization does expire after two years, around each

TABLE 5.2. NAVFAC GOALS COMPARED TO ACTUAL NAVFAC PERFORMANCE.

Performance Item	NAVFAC Goal	All Navy MILCON Projects	Large MILCON Project Sample
I. Construction Starts*			
A. Construction Contracts Awarded Within Same FY As Project Program Year.	80% ('75 program)	70% ('75 program)	21% for mixed program years evaluated against their respective fiscal years
B. Construction Contracts Awarded By The End Of The Next FY Following The Program Year	100% ('74 program)	94% ('74 program)	87% (for mixed program years)
I. Plans And Specifications Completed Within Same FY As Project Program Year Based On Estimated Value Of Construction.	95% ('75 program)	Not Available	55% (for mixed program years)
I. Amount Of Change Orders As A Percentage Of Award Amount	3% max.	Not Available	3.1%
V. Occupancy - Facility Usable Completion Compared To Original Contract Completion Date.	Within 3 mos.	50% Within 3 mos.	52% within 3 mos. 71% within 6 mos.
V. Estimating Performance Compared To Low Acceptable Bid.	±5%	Not Available	± 10%

*For an entire project's dollar value to be counted as a construction start, one or more contracts must be awarded for at least 50 percent of the authorized amount.

October 1. Thus, projects awarded by this June 30 target date do not have to go through the reauthorization process, and do not run the risk of being cancelled. Any segment of the construction funds, regardless of size can be awarded to avoid an authorization expiring. By June 30, 1975 NAVFAC had awarded 94 percent in dollar value of the FY75 program.

In the large projects sample only 6 of 22, 27 percent, of the projects were awarded in their program year, accounting for 21 percent of the sample's dollar value. Fourteen more were started in the FY following their program year for a cumulative percentage of 84 percent, leaving two projects for award beyond the final target date. It is only logical that large complex projects will take longer to get under a single lump sum general contract than smaller ones.

5.3.2 Plans and Specifications Completed

Naturally, under the traditional approach no construction contract can be awarded until the plans and specifications are completed. Thus, NAVFAC seeks to have 95 percent of the plans completed by the end of the fiscal year which corresponds to the program year. This writer was advised that unfortunately, a NAVFAC-wide MILCON summary was not available for this category since the computer reports were inaccurate, due to the presence of much erroneous input.[3] However, the large projects sample indicates that 12 out of 21 projects, 55 percent, were completed by June 30 of their corresponding years.

5.3.3 Change Orders

The change order goal of NAVFAC is to hold cost increases to 3 percent of the original award amount. The large project sample was right at the goal with 3.1 percent, but a Navy-wide MILCON summary for change orders was not available since the computer output contained some accounting charges mixed in with the true changes to distort the results.[4] In the large projects sample, there was an average of 30 change orders per project.

5.3.4 Occupancy

NAVFAC recognizes the need for timely completion of the facility being constructed. Their goal is to have occupancy within three months of the original contract completion date at award. The large projects sample showed 52 percent of the projects projected to meet this goal. The results are not summarized NAVFAC wide for MCON projects, but a review of EFD/OICC goal reports showed that of 70 jobs of various sizes completed in FY 75 which had reported contract completion dates, 35 of them or 50 percent had completed within the goal.[5]

5.3.5 Estimating Performance

NAVFAC sets the tolerance for estimates to be within ±5 percent of the low bid. This item is not reported on in the goal reports, but in the writer's large projects sample, the variance averaged ±10 percent for 17 jobs after allowing for two widely deviant estimates. Good estimating performance has become extremely difficult within the last few years. The FY 74 program was plagued with highly escalated bids due to the rampant inflation in construction, the high employment of construction resources, and the high uncertainty in the future behavior of labor and material, equipment and fuel prices. The FY 75 program was just the opposite, with bids coming in significantly under the estimates due to:

(1) the slowdown in construction activity in the private sector which increased competitive activity in the public sector,

(2) the slackening of inflation and material prices, and stocks,

(3) the stabilization of fuel , and

(4) the NAVFAC estimators' natural tendency to figure on the high side in reaction to the FY 74 program bids.

One observer also noted that suppliers listed prices artifically high to protect themselves from price controls, while the actual prices paid by contractors were drastically discounted. All these factors could also account for a high estimated project cost.

5.3.6 Large Projects Time Performance

The design, bid and construction times were calculated, since one of the main advantages CM offers is project time reduction. The findings showed that design time averaged 14 months. As noted in Chapter 3, it must be recognized that design may begin up to a year or more before the funds are available for construction. The bid time, which is the time from completion of design to award of the construction contract, averaged 3.5 months. The average construction time was calculated at 24 months. This accounts for a total project time of 41 months, from beginning of design to construction completion. This 3-1/2 years, coupled with the project submission and evaluation time before design is authorized, brings the project life cycle to approximately five years.

5.4 Qualitative Evaluation

The quantitative measures of a project are often inaccurate in describing the performance of a single project or even a group of projects. Thus, some qualitative judgments must be expressed in order to gain some notion of the effectiveness of the system. Such items as quality, constructability, marketability, and contractor management ability may in some ways be quantifiable, but figures can only indicate a limited amount of information. Certain subjective information needs to be gathered and studied to make a proper evaluation. In this section, the writer attempts to bring together some opinions on areas of a project which would receive different treatment under the CM techniques as opposed to the traditional approach.

5.4.1 Quality

Quality is a difficult area with which to deal. The standards for quality are defined by the plans, specifications, customs, standard practices, and even the character of the contractor. The vehicle through which quality is assured is the inspection program. Large sophisticated project manager organizations like NAVFAC have maintained sizeable inspection forces to guarantee that quality is achieved. NAVFAC's close inspection strategy for quality control developed implications of government supervision which in some cases, made the Navy liable for defective

performance. As discussed in Chapter 3, NAVFAC adopted the Contractor Quality Control Program (CQC) whereby the contractor maintained a construction inspector on his staff to fulfill the role previously handled by the Navy inspector.

The comments of persons who have worked with CQC have been quite informative. One comment which is heard on a recurring basis is that the effectiveness of the CQC program depends on the quality of the contractor. Top notch contractors have effective CQC programs, while low quality contractors have poor CQC programs. The effectiveness of CQC was also said to depend on the quality and experience of the contractor's CQC representative. The CQC "rep" is usually from within the contractor's organization, even though some contractors have hired testing firms to do CQC. One respondent noted a situation where a particularly good CQC representative, who was finding numerous deficiencies in his own contractor's work, was fired and replaced before the contract was finished.

Another person noted that CQC was not supposed to increase the construction cost because the CQC representative was always on site or at least under the contractor's control, so the contractor would not be delayed by waiting for government inspection. However, this same person noted that some contractors are claiming that their CQC costs are running about 2 percent of the total project cost. He indicated that contractors are extending this overhead cost to change order claims as well.

One individual noted that CQC was good because it removed the implications of tacit approval by the Navy, and it might even in some cases extend the warranty past the traditional one year to include latent defects in construction which may not appear until much later. He also noted that the day-to-day record keeping of the CQC representative seemed to be better in some cases where it has been done properly, because the Navy inspectors did not have time under the old system.

Of those who commented on CQC, nearly everyone mentioned that significant levels of effort were required to make the system work. The education of contractors was the key to making the system work in some situations while other builders fought CQC all the way. Therefore, one of

the variables in the success or failure of CQC on individual projects seems to be the contractor himself.

5.4.2 Constructability

One of the most common complaints on any construction site are the problems and inefficiencies created by the plans and specifications. Since contractor input into the design usually helps reduce the inefficiencies, this writer sought information on the extent of this input to NAVFAC design. It was found that participation of construction people in the design phase was cursory at the most. Though ROICC and EFD Construction Division personnel were usually invited to attend design review conferences and were allowed to view the plans before they were advertised, these measures were not very productive and came too late. The ROICC and Construction Division personnel claimed that most of their recommended changes were ignored. When their comments were recognized the personnel were told that to make the revisions would hold up the award date, so they should wait and negotiate a change order. Since most field personnel were so busy with day-to-day administration of construction in progress, and since little importance was attached to their input, the designs they received for comments were given little attention. On the other side of the organization, one EFD Design Division member criticized the field inputs as not being real constructability inputs, but more concerned with contractual procedures and technicalities. The NAVFAC system seems to operate under the assumption that constructability optimization is included in the responsibility of the A-E who is retained to design the project.

5.4.3 Marketability

Input of construction market information into the design is also left mostly to the A-E, under the NAVFAC concept. The cost behavior and availability of construction labor and material are assumed to be included in the designs and estimates produced by the A-E. One questionnaire respondent noted that the A-E on his project had produced a good design, but the talent for the type of construction did not exist in the locality of the site. The estimating variance of $\pm$10 percent also could indicate a

lack of market information. Even though each project needs to have construction market input to the design, the thoroughness of a market study as needed under a CM project may have less value for a traditional project. This is due to the fact that the design is done in advance under the traditional method, and market conditions are more likely to change over this longer lapse of time. Another market variable is the competitiveness of the project, which is many times a function of the timing of the bid opening. The EFD Contracts Division has the responsibility for setting the opening date and time. One person involved in this area noted that for big projects the local AGC near the potential project site is notified to ensure the opening date does not conflict with other openings or contractor events in the area. The large projects sample noted earlier the average was six bidders per bid opening, so there seemed to be reasonable competitiveness.

5.5 Conclusion

NAVFAC has been able to produce one of the more effective traditional approaches to construction among governmental agencies. Even though there seems to be room for improvement in estimating, getting construction started, minimizing change orders, controling quality, finishing on time and producing more construction efficient designs, the total design, bid and construction average time of 41 months compares favorably to the 59 months required by the General Services Administration prior to their switch to the CM approach.[6] Even GSA's original prediction for the new approach was 48 months, from the selection of A-E and CM to the completion of construction.[7] The next chapter will look at the actual performance of the new GSA System.

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CHAPTER 6

ANALYSIS AND EVALUATION OF GOVERNMENTAL CM SYSTEMS

6.1 General

This chapter explores the performance of CM systems as used by Federal governmental agencies. Unfortunately, quantitative data have not been easy to obtain. The two biggest users of CM, the General Services Administration (GSA) and the Department of Health, Education, and Welfare (HEW), have not been collecting data to monitor their overall CM programs. As a result, HEW was not able to provide any quantitative data, and GSA had to gather information specifically at the request of the writer. It was also limited to information available from their Central Office in Washington, D.C. In the writer's opinion, the material on CM performance in this chapter is not comprehensive, but it appears to be more than what has been gathered before this study. Therefore, the data collected can serve the purpose of drawing some basic conclusions about the CM approach. In the future, data should be easier to obtain as CM projects begin to multiply and owner/project manager organizations need to quantitatively determine the benefits of CM jobs.

6.2 CM Approaches Used in Governmental Agencies

6.2.1 GSA's Public Building Service (PBS)

The GSA-PBS uses the approach nearly identical to the "pure" CM method described in Chapter 4. The CM participates in the design phase, manages the contractors in the construction phase, and maintains schedule and cost control over the entire process. He does this as an agent of the Public Building Service, and he bears no financial risk in the project.

6.2.2 Department of Health, Education and Welfare (HEW)

The Office of Facilities Engineering and Property Management of HEW administers the procedures under which certain federally assisted projects are constructed, as well as some in-house HEW jobs. Their approach to phased construction requires the CM to guarantee a maximum price so that the CM does assume the financial risk for the budget success of the project.

6.2.3 Other Systems

There are variations to the systems cited above, such as the University of California approach. Under this system, firms bid for CM services during the design phase. The selected CM is also permitted to bid against other contractors for the various contract packages, to ensure a high degree of competition. However, since GSA and HEW are the two most prominent users of CM within the federal government, these two systems will be analyzed in detail. Due to the availability of information, the GSA system will receive a more thorough treatment than the HEW approach.

6.3 GSA's CM Approach

6.3.1 GSA's Self-Examination

In March 1970 GSA issued a study of the construction contracting systems used by the PBS and other organizations. The study indicated that the PBS was not very effective in procuring contract construction. The following facts were revealed:

(1) Design and construction time for a traditionally built \$10 million Federal Office Building was taking 59 months. When considering preliminary planning time before the design begins, the completion of construction could be expected at eight years after project submission.[1]

(2) Design was taking 24 months to accomplish, while the PBS standard called for only 12.5 months. The actual design time was taking 16 months, but an additional 8 months was being expended by the various PBS reviews. This long, fragmented process prevented the

A-E from continuing the same personnel on the design. Other factors contributing to design slippage were:

(a) Rigid guide specifications;

(b) Inadequate project program description;

(c) Client and PBS changes which increased in proportion to length of design time;

(d) Client agencies' failure to conduct timely reviews;

(e) The desire by PBS to redesign the A-E's work;

(f) The expenditure of excessive review time to achieve disproportionately small savings;

(g) Prolonged consideration of changes;

(h) Double review on many projects by the PBS regional office and the Central Office in Washington, D.C.[2]

(3) Many of the designs as finally developed in contract documents exceeded the project budget. Architects often viewed the Federal government as a client with sufficient resources to cover the project cost, even if the budget was exceeded. Other architects appeared to have only a limited ability to forecast the cost of their design decisions. Additional causes for "over-design" were attributed to the fact that the project was being estimated for a considerable time into the future, and the fact that the PBS failed to stop the architect when a budget-exceeding over design was detected. In some cases, the PBS personnel led the A-E's to believe more funds would be provided to increase the budget.[3]

(4) There was a two to three year lag between the time funds were appropriated by Congress to purchase the site and design the project, and the time when the money was provided by the lawmakers for construction.[4]

(5) The advertisement, bid and award consumed four to five months, compared to the PBS target of two months.[5]

(6) The standard allowable time for construction was 24 months, but the actual building process was consuming an average of 30 months. Liquidated damages were highly ineffective in motivating time performance. Of the 320 projects examined, the study indicated only 25 percent were performed on schedule, while only 12 percent were assessed any liquidated damages. In fact, some contractors indicated enforcement could be avoided to a large degree through processing delay claims.[6]

(7) Change orders were running at 6.74 percent of the project cost, which was up 14 percent from a study done eight years earlier. Tenant changes accounted for 62.7 percent of the value of these changes. Design errors and omissions were only 16.9 percent of the dollar value, but accounted for one-half of the total number of change orders. Processing of change orders was extremely slow, since field personnel only had authority for changes up to $1,000, and since a detailed estimate was required on changes over $500.[7]

(8) The project responsibility within PBS was fragmented and uncoordinated. The Office of Space Management acquired the site and prepared the space directives for the A-E. The Office of Design and Construction handled the design and construction phases and the Office of Building Management furnished information relating to the operation of the building. Among these three divisions, there was no single overall point of responsibility. At the time of the study, a decentralization plan was to have been implemented to transfer more responsibilities to the regional offices. Various responsibilities had been transferred, others had not, and in most cases the resources, guidance and technical support had not been provided with the increased workload. Furthermore, the PBS regional personnel reported to the Regional Commissioner of GSA, who in turn reported to the Administrator of GSA, rather than to the Commissioner of PBS. This organizational and authority structure made PBS highly ineffective in solving design and construction problems.[8]

6.3.2 GSA's Examination Of The Private Sector

GSA also surveyed the practices of owners in the private sector such as industrial firms and commercial developers, to obtain new facilities. The industrial firms examined were Ford, General Electric, General Motors, IBM, and New York Telephone Company which have an annual construction volume from $160 to $400 million. GSA's finding among industrial firms were as follows:

(1) The industrial firms procured construction in a traditional manner of designing, bidding,constructing, but the time for a $10 million office building was only 24 months from start of design to completion of construction.[9]

(2) The design review is conducted concurrently as the design progresses, with a company project manager spending much time in the A-E's office. The design reviews tend to be more conceptual and less detailed.[10]

(3) Most of the industrial firms maintained automated and sophisticated cost accumulation systems. The costs of current projects were being processed and used as a basis for estimating the cost of new construction and changes.[11]

(4) Change orders for these companies averaged less than 4 percent of the contract price. The firms placed a high emphasis on expedicious processing of claims.[12]

(5) Most companies did not use liquidated damages or performance bonds, and they used less inspection than GSA; however, the contractors were prequalified and rated on performance for the future opportunity to bid.[13]

GSA interviewed a number of general contractors who had experience in developing and constructing office buildings. They included Turner, Fuller, Tishman, Bateson, Hyman and Volpe. The findings were as follows:

(1) Time is of the essence to a developer so tight schedules are imposed and phased construction, overlapping design and construction, is used to the maximum extent possible. When using phased

construction, developers found the apparent risk of a high incidence of changes during the building phase was not a significant problem.[14]

(2) The specifications used by developers are more performance-oriented and less detailed, thus leaving greater options open during construction time. Bid solicitations frequently use specified alternatives, and contractors were allowed to make proposals on materials or systems to reduce the cost of construction. A number of the general contractors who were interviewed stated that detailed expertise in the electrical and mechanical areas came from the subcontractors.[15]

(3) The cost of the building was kept at a minimum through the CM technique by maintaining the benefits of competition by bidding at the subcontract level, while constantly striving through construction inputs to achieve the most cost effective design.[16]

(4) The contractors noted that the decision making capability of the developer was the key to success. The most effective developers were those who utilized a single, well-qualified project manager who possessed substantial authority.[17]

6.3.3 Study Recommendations

The recommendations resulting from this GSA study were:

(1) Preliminary planning funds should be used to develop the project, acquire the site and hire the A-E.[18]

(2) The construction should be funded by one lump sum appropriation or a revolving building fund for all PBS projects.[19]

(3) Cost estimates should be improved by reducing the lag time in getting into the construction phase, and using a CM on major projects to perform the estimating.[20]

(4) A-E quality should be improved by rating past performance and selecting on that basis. Also, the A-E should specify what persons will work on the design and PBS should insist that these people do the job.[21]

(5) Reduce the design time to standards prevalent in industry which can be partially achieved by concurrently reviewing design as it is produced.[22]

(6) Revise the guide specifications to provide more flexibility for the architect.[23]

(7) Continually validate the estimated construction costs during the design phase, and take forthright action to revise designs or increase budgets when problems are indicated. CM's should be used on major projects to serve these functions.[24]

(8) Expedite change order processing by delegating up to $5,000 authority to field personnel, and by devoting more management attention to contractors' priced proposals.[25]

(9) Adopt procedures to speed up the delivery of decisions to contractors, and take other actions to reduce construction time to match that of private industry. Contractors who have worked on both private and PBS construction noted that PBS projects were characterized by a feeling of a lack of urgency and a general failure to make decisions in a timely fashion.[26]

(10) The sequential design, bid, construct system should still be used for other than major projects, but the system should be modified to make it more responsive.[27]

(11) Use CM system for multistory office buildings, complex design projects and other projects over $5 million.[28]

(12) Create a project management organization for all new construction projects.[29]

(13) Install an overall CPM for each major project.[30]

(14) Increase delegation of authority and provide more clerical, administrative and data processing support for professional employees to increase their productivity.[31]

(15) Decentralization of PBS should be accomplished by providing adequate personnel to handle a reasonable volume of moderately

sized construction projects. Major projects should be assigned to regions where there is clear evidence that staff capability exists to handle these jobs.[32]

6.3.4 Implementation of Study Recommendations

The recommendations cited in the previous section were the point of departure from which PBS launched into the use of the CM approach. However, for projects in excess of $5 million CM could not be used effectively until certain changes in PBS and the governmental environment were adopted. There included (1) the method of funding; (2) PBS in-house organizational changes; and (3) site selection and building program development.

6.3.4.1 Funding of GSA Projects

If CM and phased construction are to be used, the funds must be readily available to commence construction while the design process is still in an early stage. It can be seen why CM was not adaptable to the existing PBS project budget cycle, since historically there was a two to three year lag between the appropriation of design money and the funding of construction. However, PBS then took advantage of the Federal Building Fund (FBF), which had been formed to charge "rent" to the federal agencies using GSA buildings. These agencies then had to budget for and transfer funds to the FBF based upon the amount of space they occupied. The purpose of the FBF was to provide a proper accounting of costs incurred by agencies of the government; however, PBS was able to win support for the idea that the fund could be used to finance new construction.[33] The Public Buildings Amendment of 1972 made the use of these funds for new construction a reality. Authorization of the projects by the Congress remains as a requirement.[34]

6.3.4.2 PBS Organizational Realignment

As noted in the 1970 GSA self-study, a key variable in using CM and phased design-construct approach was the use of a project manager (PM) to serve as the single point of responsibility on major projects. Large, high interest projects such as the Smithsonian Air and Space Museum in Washington,

D.C. and the Regional Social Security Program Centers are handled by PM's located in the PBS Central Office in Washington, D.C. The PM is involved in every phase of the project, from the initial project development and site acquisition to the final occupancy and close-out of all contracts. The total project responsibility and involvement of the PM distinguishes him from the CM, who works for the PM and whose functions are to provide construction technology and management expertise. The PM's general duties are outlined in Appendix E. PBS officials refer to these PM's as mini-commissioners because they have nearly all the authority of the PBS Commissioner, but are limited to the PM's designated project. GSA's first standard CM contract used the term Project Manager in the place of such traditional terms as the Government and the Contracting Officer.

Projects of less interest to the Central Office, but which are still large enough to qualify for use of CM are assigned Project Directors (PD) from the appropriate regional office. These Project Directors perform the same functions as the PM's do.[35]

A PM's staff is actually very small, consisting only of the PM, his assistant and a few support personnel. Despite the lean staffing of the PM office, the involvement of a large number of PBS personnel on large CM projects still remains a fact. The bulk of these in-house PBS employees come from the regional offices. These personnel perform much the same functions that they did under the traditional systems: reviewing designs, advertising and awarding contracts, performing some field inspection, plus administering nontechnical government programs such as Equal Employment Oppoutunity, Small Business Adminstration contracting, Davis-Bacon wage rate adminstration, etc.

These regional PBS personnel report to their superiors in the regional office, but when CM jobs are working in their region these employees are made aware of the PM's or PD's authority and instructed to cooperate fully with him to ensure PBS does its part to meet the project schedule, and performs its work on these projects expeditiously.

There are a number of reasons why the human resources of PBS cannot be divided among the PM's/PD's to form exclusive task-oriented organizations:

(1) The majority of PBS's work on repair and construction jobs is less than $5 million, so qualified personnel must be available to handle these projects in the traditional manner.

(2) The meshing of work from CM jobs and smaller projects allows PBS to even out its employee work load. Even when using phased construction on a large project, the work load of design, contract and construction personnel assigned exclusively to the job will vary.

(3) The assignment of technical personnel to a project on an exclusive basis would dilute the in-house technical expertise of PBS, and prevent the meaningful communication and feedback between numbers of a technical speciality that occurs when they are located in the same office.

Thus, the organizational strategy of GSA in accomplishing CM projects resembles what is commonly referred to as a matrix organization, as shown in Fig. 6.1. The formal organization remains structured along functional lines, while project or product-oriented managers perform an integrating function in using resources from each of these functional areas to achieve the desired results of the project or product.[36]

The regional PBS organizations did not go untouched from some reorganization, however, even the CM and PM techniques could not completely solve the less than satisfactory project performance noted in the study, without some organizational modifications in the regions. For example, Fig. 6.2 shows the former organizational arrangement of PBS in Region III, GSA's largest region in terms of workload. Figure 6.3 shows the modified version of Region III. The main feature of the change was to retain the contracts and highly specialized technical fields in a centralized function. The design and construction departments were combined into the operations

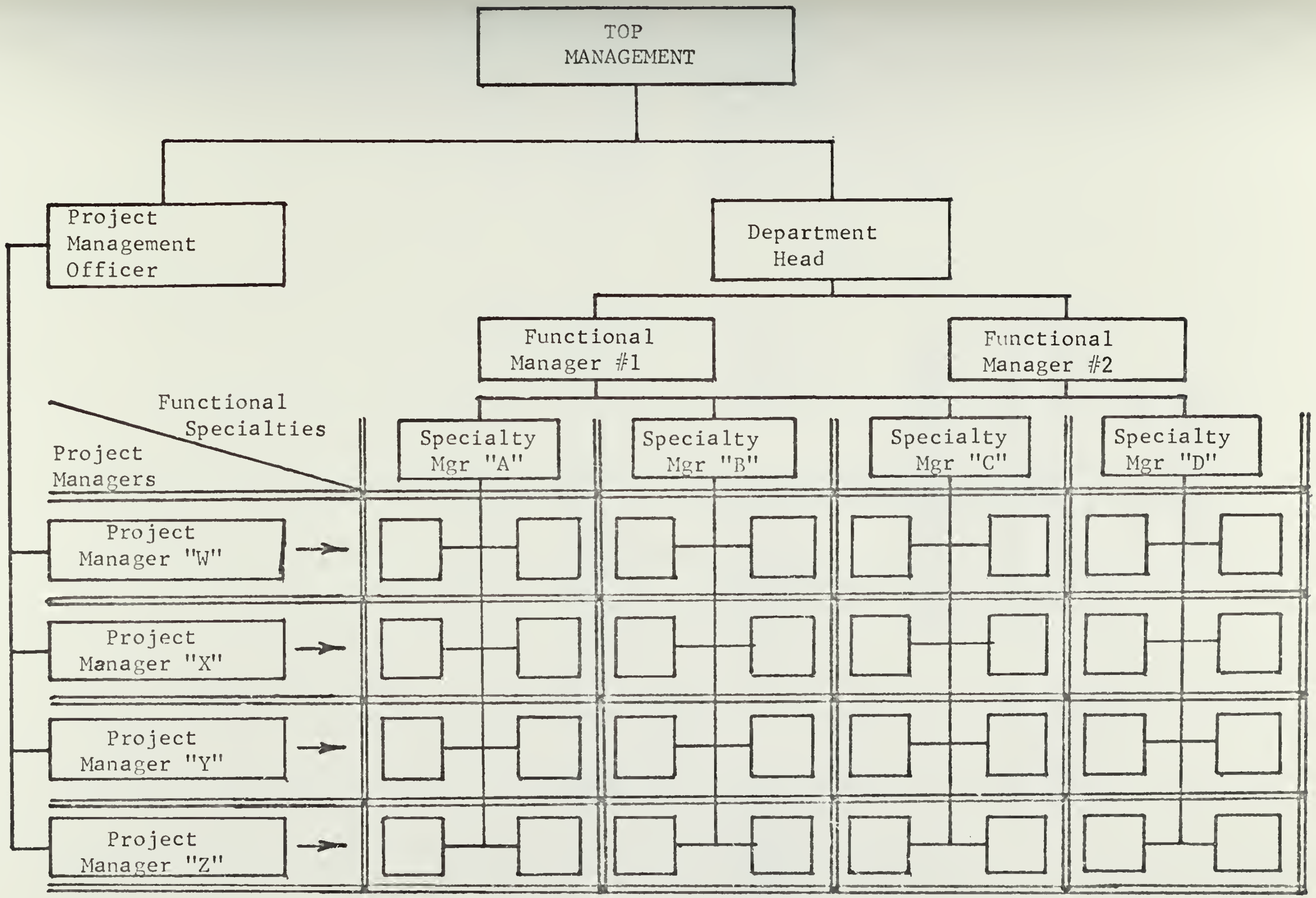

Fig. 6.1. Typical Matrix Organization.

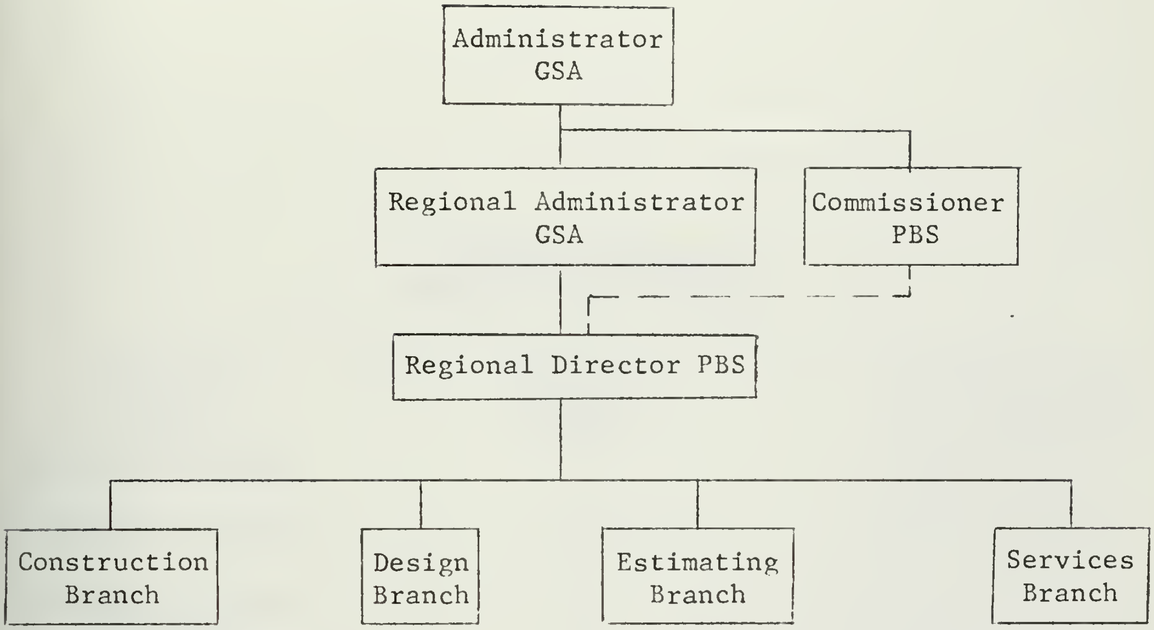

Fig. 6.2. Old PBS Organization in GSA Region III.

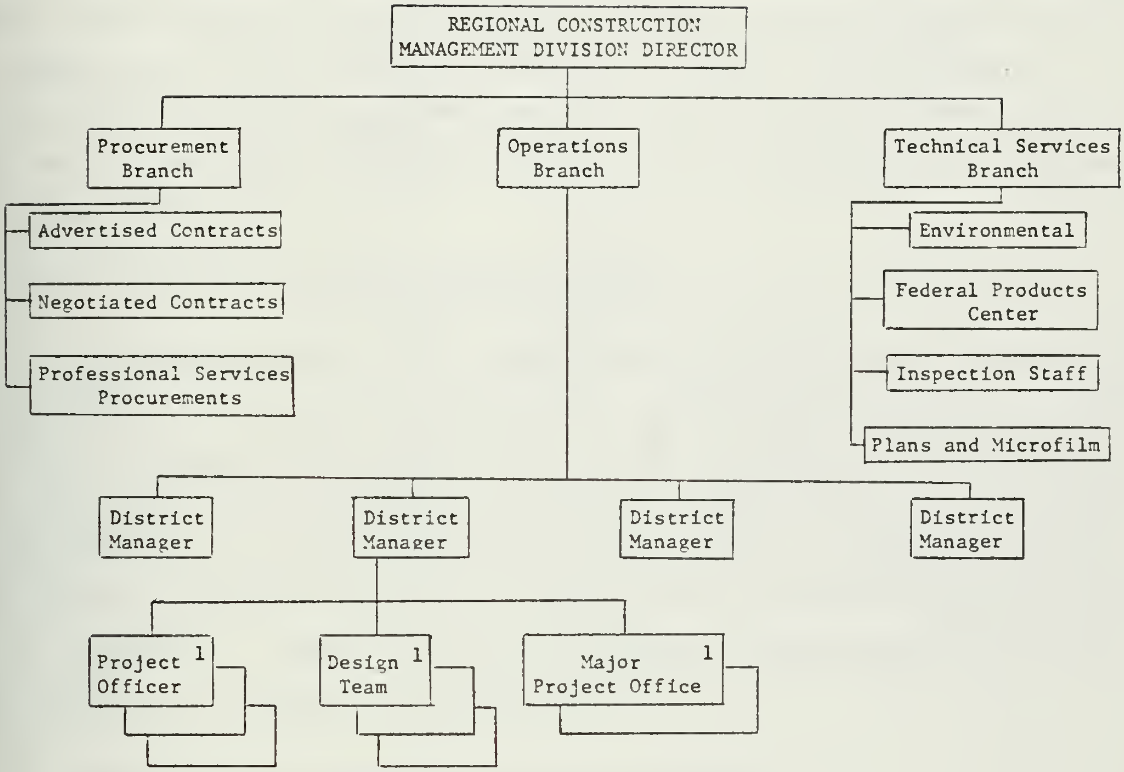

Fig. 6.3. New PBS Organization in GSA Region III.

branch and further decentralized by districts. Each district approached projects or groups of projects through multi-disciplined design teams, project officers and, when necessary, major project field offices.[37]

The PM primarily uses the personnel of the Operations Department for design review and the on-site resident engineer function. The procurement department handles the award and negotiation of all contracts, while the technical service department provides special functions such as specialized inspections, etc. Figure 6.4 shows the relationship between the two formal organizations, the Central Office PM and the regional Construction Management Division, with the dotted lines indicating the relationships.[38]

6.3.4.3 Site Selection and Building Program

A key ingredient that is prerequisite to the hiring of a CM and A-E is the selection of the site, since many federal buildings are to be built where no U.S. government land exists. One GSA official insisted that the potential job site be procured or at least be under option to the federal government before hiring outside professionals.[39] The building program must also be completed to give the A-E and CM an accurate scope of what is to be performed.[40] These functions are typical responsibilities of the PM with his total project accountability.

6.3.5 Quantitative Performance Data On CM Projects

The most illusive ingredient in the evaluation of existing CM systems is the collection of quantitative data. To date, GSA had only completed six CM projects and further, little information is available from the PBS Central Office. However, the writer was able to obtain evaluative information on these six projects as contained in Table 6.1. Summary data are listed in Table 6.2, and the following sections discuss the findings.

6.3.5.1 Project Time

Total project time averaged 38 months, even though design took 18 months and construction lasted a mean of 29 months. Assuming the design

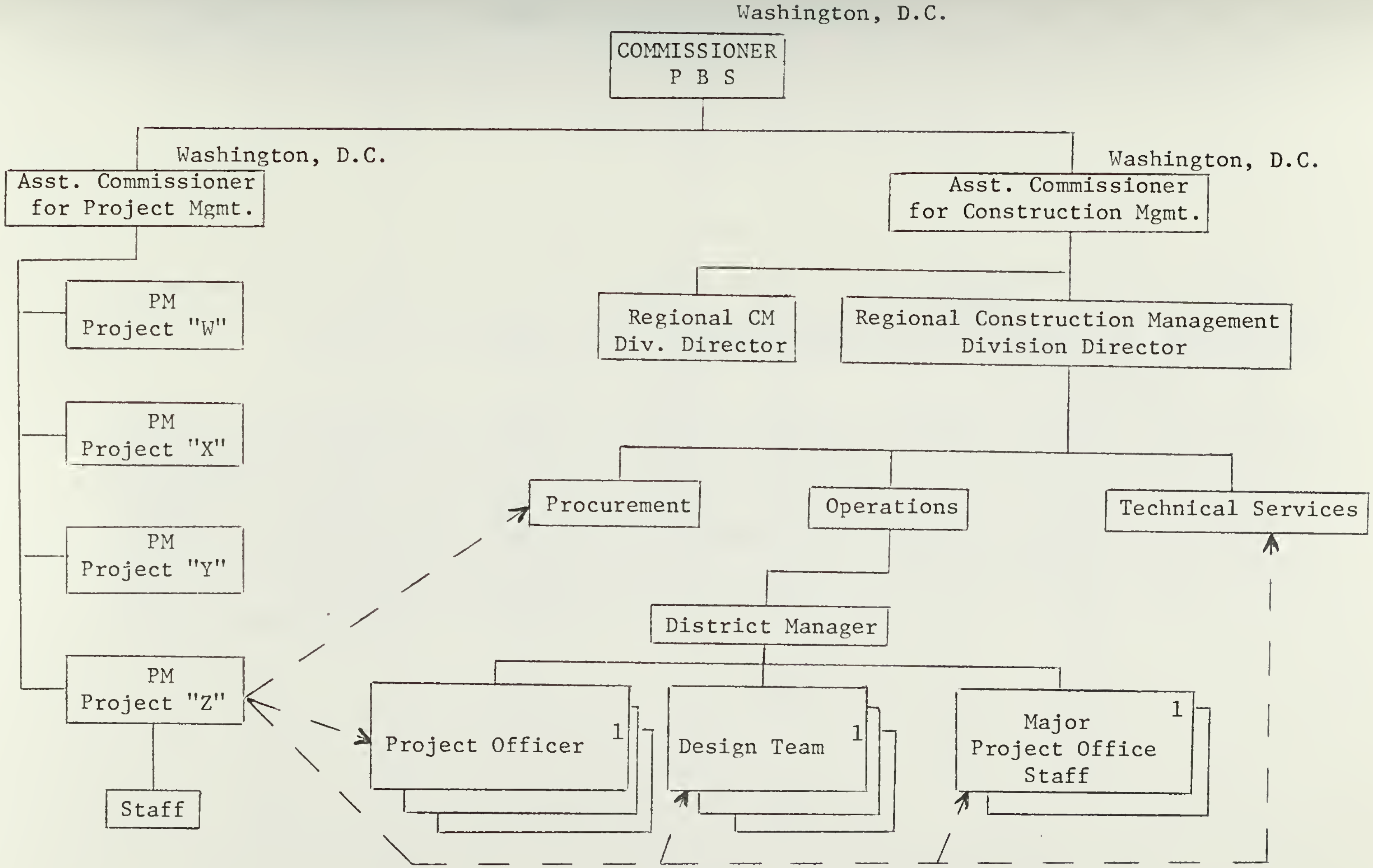

Fig. 6.4. Interrelation Between PM and Regional PBS Organization.

TABLE 6.1. GSA CM Project Data.

TIME DATA

PROJECT (1)	DESIGN Start/Completion (2)	DESIGN Time (3)	CM HIRED (4)	CONSTRUCTION First Award (5)	CONSTRUCTION Plan Compl / Act Compl (6)	CONSTRUCTION Time (7)	TOTAL TIME (8)
Social Security Program Center, Philadelphia, Pa	14 Dec. 71 / 1 Mar. 74	27	15 Nov 71	8 Mar 73	28 Jan 75 / 15 Jul 75	28	43
Smithsonian Institute Air and Space Museum, Washington, D.C.	14 Oct 71 / 1 Feb 73	16	25 Feb 72	11 May 72	30 Jun 75 / 30 Jun 75	34	45
Washington Technical Institute Phase I, Washington, D.C.	2 Jun 72 / 15 Jun 72	12	16 Aug 72	15 Sep 72	30 Jun 76 / 12 Sep 75	36	39
Federal Youth Center, Pleasanton, Ca	8 Mar. 72 / 29 May 73	15	7 Apr. 72	2 Aug 72	1 Aug 74 / 1 Aug 74	24	29
Metropolitan Correctional Center, San Diego, Ca	6 Jul 72 / 17 May 72	10	15 Jun 72	29 Jan. 77	1 Feb 76 / 31 Oct 76	21	28
Social Security Program Center, Richmond, Ca	14 Dec 71 / 26 Apr 74	29	15 Nov 71	26 Mar 73	11 Apr. 75 / 29 Jul 75	28	48
Total		109				171	278

COST DATA (VALUES IN $000)

PROJECT (1)	Construction Contract Awards # (9)	Construction Contract Awards Amount (10)	CM's General Conditions Work (11)	Direct Construction Costs (12) (10)+(11)	Original Government Estimate (13)	Change Order Amount (14)	Change Order % (15) (14)÷(12)	Final Direct Construction Cost (16) (12)+(14)	Cost of CM Less General Condition Items Amount (17)	Cost of CM Less General Condition Items % (18) (17)÷(13)	Total Cost of CM Amount (19) (17)+(11)	Total Cost of CM % (20) (19)÷(13)	Total Construction Cost (21) (16)+(17)
Social Security Program Center, Philadelphia, Pa	17	21,774	1,092	22,866	26,416	1,138	5.0	24,004	500	1.9	1,592	6.0	24,504
Smithsonian Institute Air and Space Museum, Washington, D.C.	24	25,077	1,471	26,545	32,951	2,299	8.7	28,844	1,427	4.3	2,900	8.8	30,271
Washington Technical Institute Phase I, Washington, D.C.	19	10,492	569	11,061	12,783	417	2.8	11,478	955*	7.5	1,524	11.9	12,433
Federal Youth Center, Pleasanton, Ca	20	5,272	200	5,472	5,591	10	0.2	5,482	100	1.8	300	5.4	5,582
Metropolitan Correctional Center, San Diego, Ca	29	11,837	400	12,237	12,905	871	7.1	13,108	192	1.5	592	4.6	13,300
Social Security Program Center, Richmond, Ca	21	23,887	2,000	25,887	31,718	2,387	9.2	28,274	500	1.6	2,500	8.0	28,774
Total	130	98,136	5,736	104,068	122,046	7,122	6.8	111,190	3,674	3.0*	9,408	7.7*	114,814

*CM performed some functions not normally performed by a CM in the Washington Technical Institute Project and high cost of CM distorts cumulative figure for CM costs somewhat. Deleting Project Column (18) would be 2.5% and Column (20) would be 7.2%

TABLE 6.2. GSA CM Project Performance.

(1) Length of Design Time. Average was 18 months.

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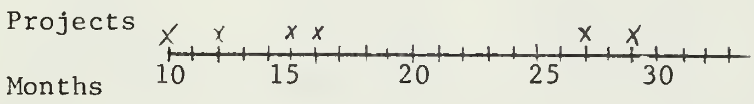
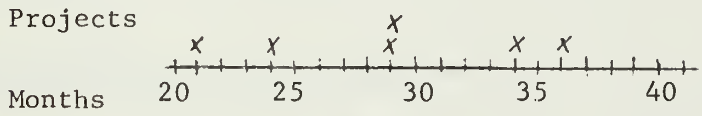


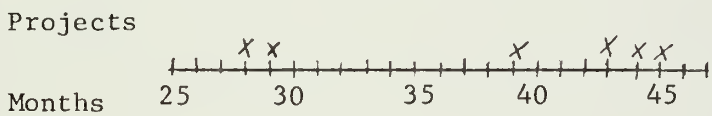
(2) Length of Construction Time. Average was 28.5 months.

D I S T R I B U T I O N



(3) Length of Total Project Time. Average was 38 months.

D I S T R I B U T I O N



(4) Average Cost of CM (not including reimbursible general conditions work work) was 2.5 percent of estimated construction cost.

(5) Average Cost of All CM Services (including all reimbursible work) was 7.2 percent.

(6) Change Orders Averaged 6.8 percent of initial award amount.

(7) Estimating Performance had a variance of 13 percent with all projects overestimated.

TABLE 6.2. (Cont.)

(8) On Schedule Performance.

	Project Completed Within 3 mos. of Planned Compl. Date	Between 3 to 6 mos. After Planned Compl. Date	Beyond 6 mos. After Planned Compl. Date	TOTAL
Number of Projects	1	2	3	6

(9) Average Project Size was $19.1 million.

(10) Average Number of Contracts per Project was 22.

(11) Average Contract Amount was $811,000.

work did not stretch out over a longer period of time because of the phasing of design and construction, the fast tracking procedure appears to have saved nine months. If two months are allowed for bid time, then the saving would be eleven months or nearly one year. Compared to the 1970 GSA study findings of 59 months for design and construction of a typical $10 million office building, the CM projects, averaging $17.5 million, were done in 35 percent less time, or a little less than two years. Figure 6.5 compares the findings of this study to those of the 1970 study. The differences in construction time are not significant; however, the CM projects are larger and this factor usually affects the length of the building period. The main savings come from reducing the design time by six months, and elimination of the five month dead time between the finish of design and the commencement of construction.

6.3.5.2 CM Fees and Costs

On the six projects the CM's fees ranged from 1.5 percent to 7.5 percent of the estimated construction cost. This does not consider the construction work done by the CM's own forces in providing the temporary and common-use facilities or other general condition items. On one of the six projects, Phase I of the Washington Technical Institute, the CM performed some extra services normally provided by the government, thus, the fee was 7.5 percent. Without including this project, the remaining five projects averaged 2.5 percent of the estimated construction cost.

The general conditions work by CM forces ranged from $200,000 on a $5.6 million project to $2 million on a $31 million job. The average cost of the CM's for all services provided was 7.7 percent and 7.2 percent when the Washington Technical Institute job is not considered in the sample. However, since the general condition items would normally be a direct labor and material item for the general contractor, the real cost of the CM's design consultation and management services are the ones cited in the preceding paragraph as averaging 2.5 percent.

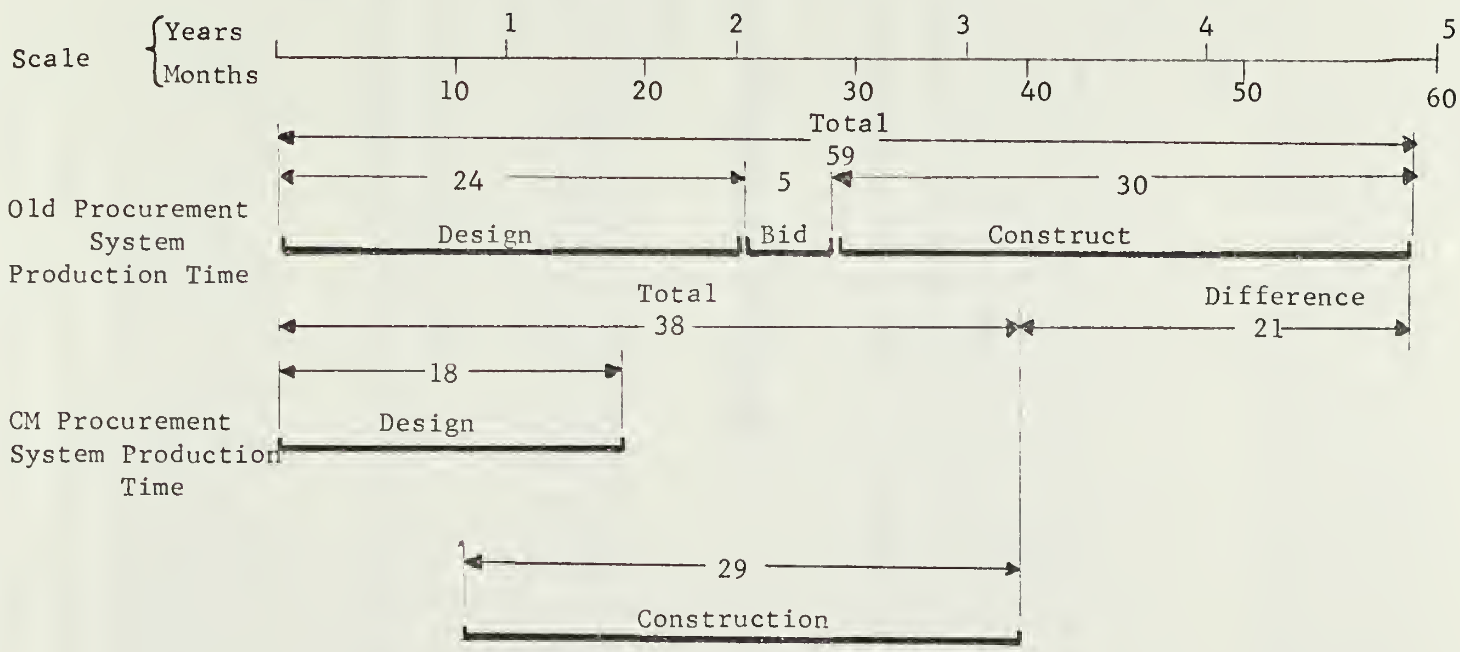


Fig. 6.5. GSA Design - Construction Time Results.

6.3.5.3 Estimating Performance

The estimating performance of the CM's was +13 percent with all of the projects bid below the estimate. Even though, +13 percent is a high variance, the estimates made on a conceptual basis have a higher level of uncertainty, and thus, it is naturally more difficult to determine accurate costs.

6.3.5.4 Contract Data

Construction contract awards on GSA CM projects ranged from 17 to 29 per project, with the average being 22. The range of contract amounts was not available, but the average contract award was just over $800,000. This is a good indication that bidding was open to many more bidders than on a large conventional project with a large general contractor securing subcontractors.

6.3.6 Qualitative Information on CM Projects

6.3.6.1 Problem Areas

The most recurring problem GSA has faced with the CM approach has been the attainment of desired performance from the CM. The reasons appear to be two fold:

(1) The quality of the CM firm itself

(2) The proper definition by GSA of what services the CM is expected to deliver.

Regarding the quality of the CM, one GSA official noted that a number of firms had been terminated for poor performance. One of the six completed projects listed in Table 6.1 was handled by two different CM's since the original one was terminated. Even though GSA officials and their publications are quick to note terminations have been and will be issued for poor performance, specific reasons for these actions were not made available. However, one can infer from changes and additions to GSA's "second generation" CM handbook the functional weakness of some CM's. Under the subheading of "Problem Areas" from the manual are listed:

(1) A-E's who are interested in providing CM services should have the capability to manage, direct, and coordinate the day-to-day field operations of many separate construction contractors.

(2) Meaningful involvement of CM's in design development has been difficult to achieve. CM's must develop the necessary experience and expertise.

(3) CM estimates need to acquire more reliability, and CM's need to develop more expertise in conceptual estimating for the comparative evaluation of different design approaches.

(4) More meaningful and accurate feedback is required from the computerized management information system.

Furthermore, one GSA official noted that CM's have not been exercising enough leadership during the design phase. He also stated that CM's who are general contractors who have worked on a competitive bid basis have done a better overall job than CM's with other types of backgrounds.[42]

The other aspect of the problem is that the requirements of the CM have not been adequately defined. One PBS official noted that the first GSA CM contract was vague in delineating specific requirements of the CM.[43] Another PBS official stated that the revised GSA CM Manual and Contract are much more specific, and the CM is required to deliver particular items before any payment for services could be made.[44] GSA's experience indicates that even with their professional relationship to PBS, CM's cannot be expected to operate from a loosely defined document such as the typical owner-A-E contract. Perhaps this is because CM is new and without any industry-wide standards or self-regulation. That is, even CM's themselves seem to have different perceptions of what their role should be.

6.3.6.2 <u>Solutions to CM System Problems</u>

The two basic solutions to the problem areas cited in the previous section are (1) tightening the CM Selection process, and (2) revamping the GSA CM contract.

6.3.6.2.1 CM Selection Changes

Previously, the CM selection process evaluated candidate firms for a project on the basis of qualifications without price considerations. Then the five top firms were evaluated on the basis of price.[45] The CM's qualifications submission was highly oriented to the firm's construction experience, and only minor attention was given to the firm's strategy for accomplishing the proposed project. That is, the only information required of the firm was in regard to the proposed CM project staff and organization chart.

The revised method of CM selection first considers the qualifications of interested CM's then it asks the five most highly qualified firms to submit a management plan for the project with a price proposal.[46] Thus, qualifications, management plan, and price become the three factors considered for selection of a CM by GSA.

As in the original GSA CM selection scheme, the qualification requirements include:

(1) CM experience or high CM potential

(2) Financial ability to provide the necessary services

(3) Competence in civil, mechanical, electrical and structural engineering; construction estimating, cost accounting and control; tenant coordination; project management; contract negotiation and administration; contract superintendence and inspection,and other related fields

(4) Experience in constructing buildings in the general geographic area of the project or recent knowledge of local conditions.

(5) Professional and business reputation with an on-time and within-budget performance record.

However, the new system also adds the following traits of a CM concerning management information and control systems and minimum experience level.

(6) Proven competence in the implementation and maintenance of network based construction management systems, and in the application of

systematic cost control throughout the design and construction process.

(7) Ability to provide professionally qualified key personnel with a minimum of twelve years satisfactory experience in the design and construction industry that is directly related to the position they will hold on the GSA project.[47]

The qualification questionnaire for CM's shown in Appendix E, is distinctly different from the original questionnaire with its general questions. Qualification submissions must now be more specific in more areas than before. A prospective CM must now provide information never provided before on such things as:

(1) Organization of the firm

(2) Scheduling, management information and control system experience

(3) Present workload and capacity

(4) Familiarity with GSA procedures

In addition the applicant CM firm must now provide more specific information on:

(1) Personnel resources of the firm

(2) The firm's CM strategies and operations

(3) Past CM projects of the firm, including time, cost and change order data

Further, even the requirements concerning the CM's areas of financial condition and his references have been significantly expanded.[48] It is evident that GSA is seeking to overcome the problem of CM quality by concentrating on the specific items that could indicate probable success on one of their CM projects.

The management plan the five top rated firms must submit is perhaps the most unique change GSA has devised to ensure CM quality. The management plan goes beyond the overall qualifications and resources of the firm to

give PBS officials an idea of how the CM firm proposes to bring its capabilities to bear on the subject project. GSA has also specified certain functions the CM must perform, and it calls them "deliverables." The standard deliverable items of work are shown in Appendix F. The term and concept of deliverables is woven into the GSA's required management plan. It is used to serve as a comparison in evaluating CM's for selection, to reduce the uncertainty of what is expected of the CM, and to serve as a basis for payment of the CM.[49]

The CM's management plan and price proposal then consists of:

(1) A narrative of the strategy for completing the project during all phases - design, design-construction overlap, and construction.

(2) A network diagram (CPM) depicting the CM's deliverable items of work as activities and how they logically interrelate with each other and with other activities which represent major milestones in each of the three phases of the project.

(3) A lump sum contract price breakdown by deliverable items and project phases, as shown in Appendix F.

(4) An organization chart for the CM's project organization, showing the names and positions of all the nonreimbursible staff and the positions of all the tentative reimbursible job site staff to be utilized.

(5) Detailed description of the duties of all staff personnel shown on the organization charts.

(6) A nonreimbursable staff listing by position of name, work location, estimated manhours, and hourly wage rate. This would include the Construction Executive, Construction Superintendent and management information system supervisor, who are the mandatory staff, plus various engineers, draftsmen, estimators, accounting personnel, clerical personnel and any other specialists who may be required by the CM.

(7) A tentative reimbursable job-site staff listing by position giving number of employees to be hired in that category, extent of employment (full time, part time) estimated manhours, and estimated hourly wage rate.

After PBS officials evaluate the management plans and price proposals, discussions may take place between the various firms and PBS to clarify points of the plan, and the CM's may make modifications. The final plans are evaluated, along with the price and the qualifications. The evaluation is a numerical technique where each CM is graded on each of the three areas by a panel of PBS personnel. The system gives a 30 percent weight factor to qualifications and price and a 40 percent weight to the management plan. The panel compares their results and discusses differences before making the final selection.

GSA appears to have gone to great lengths to ensure that CM quality is improved, and that CM's fully understand their requirements. The management plan eventually becomes a part of the contractual documents, and the deliverables serve as a basis for payment.

6.3.6.2.2 CM Contract Changes

The changes in GSA's CM selection process should help improve the delivery of CM services, but also the standard PBS CM contract has undergone significant revisions to more explicitly define the CM's role.

The major changes to the basic CM contract are as follows:

(1) The contract which was originally a two part document, one part for services during the design phase and one part for the construction portion, but this was changed to a one piece document. Since the deliverables are well defined for all phases and the FBF provides a stable source of funds, the two part concept is not required.

(2) The scope of the project, its completion date, and maximum permissible cost were added to define the project the CM is to build, and set the cost and time limits the CM must maintain.

(3) The GSA Resident Engineer is given the added responsibility of observing the performances of the CM and the construction contractors.[54]

(4) The CM's Construction Superintendent must now be on site full time 30 days prior to the first construction contract award. The superintendent must have at least four years supervisory experience in the field.[55]

(5) The term "deliverables" is defined by the new contract as those services performed by the CM which will serve as a basis for making installment payments of the lump sum contract amount. Under the old contract, the payment time and amount were to be made at fixed milestones in the project life cycle, regardless of the level of effort exerted by the CM. The old system could not use progress payments very effectively to motivate performance. Now if a deliverable item is not performed satisfactorily, the CM does not get paid for it.

(6) The CM is assigned the objectives of ensuring that

(a) the project will be well designed by the A-E

(b) the construction will be completed as soon as possible, but not later than the completion date established by the contract

(c) the construction work will be performed in accordance with the applicable requirements

(d) the project will be completed at a project cost not to exceed the maximum amount specified by the contract.[56]

(7) Even though the preceding objectives of the CM are defined, the same clause states the CM will not be held responsible for cost overrun, time overrun, design deficiencies, and defective construction when the CM has diligently performed all that was reasonably required to prevent these problems.[57] GSA's CM manual states, "GSA wants an uninhibited CM." It is GSA's belief that freeing him of the major construction cost risks, serves the Government's best

interest by optimizing the value of his input, since he can now afford to give frank and objective advice, independent of any personal considerations of financial gain or loss in the outcome.[58]

(8) The Construction Management Control System (CMCS), GSA's own computerized network scheduling and management information and control program, is now required for use by all CM's. In the previous contract, acceptable substitute systems were allowed. CMCS includes four major subsystems:

(a) Narrative reporting

(b) Schedule Control

(c) Cost Control

(d) Financial control.[59]

The system is designed to provide pertinent reports to the various participants in the project. The logic for GSA to specify use of their own systems seems to be that since PBS plays such an active role in the course of the project under the CM approach, management information is much more critical and it requires uniformity among various projects.

(9) Even though the CM's management plan becomes part of his contract, GSA requires the plan be updated and expanded for each of the three phases of the work: design, design and construction overlap, and construction.[60]

(10) The design development and review clause has been revised to be more specific about the CM's role in this area. Also, it introduces the comment that "the CM should familiarize himself with the 'evolving' plans and specifications and shall continuously follow the development of the design through concepts, tentatives, and working drawings."[61] Thus, there is a need for the CM's continual involvement in the design, not just reviewing or estimating at specific intervals.

(11) The CM is given specific procedures to follow in the procurement of long lead items, where before he was to recommend early purchase and expedite procurement in very general terms.[62]

(12) The CM is now required to consider more factors in determing the optimum way to divide the project into contract packages. A "satisficing" CM (one whose goal is just to meet the minimum standard) who routinely divides up the packages along some predetermined norm such as the Construction Specifications Institute (CSI) divisions could pass up tremendous economies, and perhaps even create many jurisdictional or other problems. The CM is also directed to give attention to awards which could be made to the Small Business Administration (SBA) for performance by disadvantaged contracting firms.[63]

(13) The CM's responsibility for interfacing separate construction contracts has become more specific my ensuring that all construction requirements will be covered, and that each bid package clearly identifies what work is included in that separate contract.[64]

(14) Under the solicitation of bids, certain functions have been made more specific. First, the CM prepares for government issuance of the invitation for bids. Second, a prebid conference is now a GSA requirement, where before it was only recommended.[65]

(15) The Market Analysis and Stimulation of Bidder interest is an entirely new item, and the CM is required to submit a written report on this area, indicating his findings and recommendations. The CM must update and submit the report every 30 days until the final construction contract is awarded.[66]

(16) Differences between the contractor and the CM shall be resolved by the Project Manager.[67]

(17) Regarding the safety program for the project, the CM in addition to his responsibility for program preparation under the new contract, shall monitor compliance to the program and to OSHA by separate contractors and report any deficiencies.[68]

(18) In regard to construction changes, the CM's specific responsibilities are more explicit on how the CM is to handle changes eminating from various sources. The CM is now required to observe and collect data on costs incurred by contractors performing work on change orders where the price has not been negotiated

6.3.6.2.3 Monitoring CM Performance

GSA, with its new CM contract, has sought to clairfy what is required of the CM on its PBS projects. This excerpt directed at potential CM's from the GSA CM manual sums up how it expects CM's to perform when working for them:

> In the conventional building process, contractors are normally oriented to performing only what is specifically required by the construction contract. When a Construction Manager joins the Owner's side of the table, there is an extremely important psychological adjustment necessary -- TO COOPERATE, THINK, AND ACT IN TERMS OF THE OWNER'S BEST INTERESTS.
>
> Another critical aspect is the LEVEL OF EFFORT put forth by a Construction Manager. To ensure that CM offerors clearly understand the extent of performance required under the CM contract and that they fully intend to carry out the obligations, GSA has incorporated a Management Plan requirement in its selection procedures. The network diagram of the management plan specifically shows the required CM deliverables, by activities and dollar amounts, both as tangible indicators of future CM performance and as a mechanism to provide payment only for CM work actually accomplished. The management plan is integrated subsequently into the PBS-CMCS shortly after award of the CM contract and CM performance is then monitored throughout the life of the CM contract.
>
> GSA expects the Construction Manager with his sophisticated array of expertise and electronic data controls to be self-actuated, to anticipate the project needs and problems, to arrive at practical solutions, and to take effective and timely action, so that construction conflicts, cost overruns, and delay in completion are avoided or minimized. Ineffective CMs can and will be terminated.[69]

However, PBS has indicated that no formal evaluation of CM's exists within PBS. This seems somewhat contradictory, since the main motivation of the "pure" CM to perform is to build a good reputation and hope for

repeat business. Currently, PBS does not rate a CM's performance, but rating may become inevitable as the number of CM projects increases.

Since the CM approach has no dominant group to self -regulate its practices and to set its performance standards, GSA appears to be filling the role of defining the CM's job. Thus, GSA's program may eventually become a standard for CM services.

The GSA's program has had its share of problems, as might be expected with the introduction of a new and complex contracting system. The uncertainty caused by the new system was not solely confined to CM's. A-E's and contractors who participated in the initial CM projects were also uncertain as to what their roles included. However, GSA has been fortunate in that CM projects to date have performed well in terms of cost and time, which has allowed GSA to make adjustments to the system without great disruption.

In any case, the performance of CM projects has far exceeded the typical record exhibited by traditionally built PBS projects of equal size and complexity. The reader should note that changes in the PBS organization which provide a single point of responsibility, the PM, and the revised funding arrangement of the FBF to permit greater availability of funds when needed, largely contributed to the success PBS has had with CM. The total system of procuring facilities must be considered when contemplating major shifts in strategy that a conversion to CM represents.

6.4 CM - HEW Style

Even though HEW claims more than 200 projects have been accomplished under their auspices using CM, they too keep no centralized records on CM project performance.[70] Thus, no quantitative evaluation of CM can be presented, but the qualitative aspects of the system will be presented. This information is different from GSA's CM approach because HEW operates under the Guaranteed Maximum Price (GMP) concept.

6.4.1 Nature Of HEW Construction Requirements

HEW encourages the use of GMP-CM on projects which are primarily funded by Federal assistance funds. HEW is very concerned that owners whose construction is partially supported by Federal funds do not exceed the resources made available to them. In contrast to GSA, HEW exercises little control over the actual design and construction of the project. This level of control is primarily handled by the owners of the projects on which these Federal funds are to be used. This could be a hospital for which HEW has given grants to help expand their medical facility, or the board of a junior college district which has also received federal money to build a new laboratory or classroom building.

The GMP-CM then serves as a control in itself to assure HEW officials that federal grants will not prove inadequate to complete the facility. In a system where HEW exercises little direct project control and where the resources available are fixed, the GMP allows the owner to start constructing early with the assurance that sufficient funds are available to complete the project.[71]

In addition, funding for grants for construction are approved by Congress, and no project cost escalations are allowed. Therefore, HEW is highly sensitive to prevention of cost overruns.[72]

6.4.2 HEW CM Contract Features

HEW has recently issued a new manual for use on CM projects. Some of the changes and features of that new guideline follows:

(1) Defining the participants' roles has apparently become a necessity for HEW, since detailed explanations are given as to the responsibilities of the A-E and owner as well as the CM. Since CM is particularly sensitive to owner involvement and participation on HEW assisted projects, and since some owners are diverse and may have little or no engineering expertise, the need to define the owners' role becomes critical. HEW points out that the owner's representative must have the authority to make decisions, and that he must provide the necessary staff to carry out his responsibilities.

The A-E interrelationship with the system is also discussed with items that are not clearly in the CM or A-E's area, such as estimating responsibilities and bid reviews, assigned to specific participants.[73]

(2) An important addition to the revised manual is that inspection services are assigned to the owner. The owner may use one of his own personnel or a member of the A-E's staff.[74] Since the GMP creates a financial interest in the project which may sway the objectivity of the CM, he is not allowed to inspect the work.

(3) Once the GMP has been established and the construction phase of the CM contract begins, the CM must post performance and payment bonds for 100 percent of the GMP.[75]

(4) The HEW CM Contract is a two part contract. Part A is the CM's consultation services during the design phase, and Part B establishes the GMP and includes services during the construction phase. The GMP must be established before construction begins.[76] The two part contract allows the owner some degree of flexibility in discharging the CM if his performance during Part A was unsatisfactory or if the GMP is unacceptable.

(5) The new manual stresses that owners may terminate CM's during the design phase. HEW strongly recommends the inclusion of termination clauses in all CM agreements.[77] That is, CM quality appears to be a problem on HEW projects as well as GSA projects. One HEW official complained that may CM's treat the GMP like many general contractors treat their lump sum award - they frequently request change orders to increase the GMP to protect their financial interests.[78]

(6) The CM selection process is a two step procedure, with interested firms submitting qualifications in a format similar to GSA's CM questionnaire. The top rated firms are asked to submit price proposals. These proposals contain no management plan such as GSA's CM proposals. The CM gives a fixed price for Part A and

Part B.[79] Thus, the CM is selected by the owner on the basis of qualifications and price.

(7) The HEW manual states that the CM fees include the profit and overhead of the CM for the entire job, and they also include the cost of the CM's risk factor in providing the GMP. The fixed fee can be modified only when there is a change in project scope or time of completion as directed by the owner.[80] Reimbursible costs are those that may be authorized by the owner to provide the general condition items, salaries for job-site personnel below the superintendent level, and related travel and per diem costs. Part B of the CM agreement sets a ceiling of the level of reimbursible costs that will be allowed.[81] On many GMP-CM contracts in the private sector, the owner shares the savings with the CM when the job comes in below the GMP; however, HEW considers the CM to have a professional relationship with the owner, so he is obligated to minimize the project cost without a financial incentive.[82]

(8) Under the new manual, CM projects must have a GMP where previously non-GMP contracts were possible. The GMP includes all construction contracts, and all the GMP fees and reimbursements paid to the CM are required to be broken down into two formats. The first format is subdivided into the elements of contruction such as concrete, masonry, steel, electrical, etc. The second GMP breakdown is by estimate for each bid package. The first provides cost information related to the usual cost of construction elements, while the second helps the owner determine how the bids for each portion of the work are going to affect the GMP. HEW recommends that the CM be required to recertify the GMP monthly, based upon the latest set of plans and specifications.[83] Since the CM must wait until the project is sufficiently defined to negotiate a GMP, the total project time may be longer than under a "pure" CM approach.

(9) The CM is heavily involved in the advertisement, bid and award of the construction contracts; however, each award must be approved by

the owner. The new HEW manual offers the CM significant latitude in dealing with bid packages that exceed the budget for that portion of the job. Those options are:

(a) The CM may negotiate with the low bidder to reduce the price of the bid package to a cost not to exceed the budget line item price.

(b) The CM may reject all bids and issue a revised invitation for bids to be prepared by the A-E and approved by the owner.

(c) The CM may agree to perform the work with his own forces for the price of the budget line item.

(d) The CM may award to the low bidder for a price above the budget line item.[84]

6.4.3 <u>HEW Summary</u>

The HEW CM approach tries to enlist the services of a highly qualified constructor to make inputs into the design and to manage the construction. The fact that the CM works for a fee establishes a professional relationship between himself and the owner. However, the CM's financial interest in the project because of the GMP prevents him from becoming what GSA calls the "uninhibited" CM. If one were to view a horizontal scale depicting the owner-builder relationship as a function of professionalism, the GSA system would be on one end of the spectrum while at the other end there would be the traditional lump sum general contractor. The HEW CM would have to fall somewhere between the two, perhaps closer to GSA's CM.

Even though it appears that a philosophical battle rages between the two predominant CM using agencies of the federal government there is an indication that both have selected the optimum system for their own environments and organizations. GSA is concerned with building facilities which it will eventually manage and maintain. It has a large in-house engineering organization, PBS, to closely monitor the CM and to be intimately involved in project decision making. On the other hand, HEW is concerned

with the allocation and prudent use of federal funds by many diverse owners. These owners may or may not have in-house engineering staffs and they certainly will have different perceptions of a CM's responsibilities and functions. Therefore, HEW feels it can protect its investment, which is being utilized by an owner outside the HEW organization at a site remote to HEW personnel, by using the GMP as a financial guarantee. Since it would be economically prohibitive to maintain HEW project management organizations at each site where federal money is being used, the price paid for the risk assumed by the CM is justifiable.

6.5 Use of CM in the Military

Even though full scale CM's services have not been used on any military projects, the use of CM firms for construction input for design has been employed with some success.

U. S. Army Hospital, West Point. The design of this $13 million hospital proved to be too costly when the bids were opened and read. The Corps of Engineers then retained a CM for construction input to suggest revisions to the plans and specifications. The CM was credited with saving $2,138,000 of the previous low bid amount by the Corps of Engineers officer on site. The CM was hired for design consultation only, but his valuable input allowed the project to get on track and into the construction phase.[85]

2,600 Units of Family Housing, Hawaii. The Army Corps of Engineers is also building an extremely large housing project in Hawaii that is valued at approximately $100 million. Since no single housing contractor in Hawaii had the capacity to bid the job and allowable housing costs are highly restrictive, the Corps hired a CM as a construction consultant to:

(a) estimate the project
(b) present cost alternatives
(c) make packaging recommendations
(d) review the design for constructability.[86]

U. S. Naval Hospital, Camp LeJeune, North Carolina. On this project, which is currently being designed, a CM has been retained for

design consultation. The CM has participated in many of the earlier conceptual design decisions. He made a number of significant contributions to design to make the project more constructable, such as changing the configuration of a twin tower concept to a single tower to eliminate the requirement for one tower crane and the separation of a low clinic building from the tower area to allow simultaneous work on both sections. These inputs have reduced the need for specialized construction equipment and enabled a shorter job duration.

CM's involvement in military projects has been limited to date to participation in the design phase. However, CM advocates feel that CM involvement in the design phase is more effective when it is utilized in the construction phase as well. That is, the CM exercises the utmost care and prudence in suggesting construction economies when he knows he will soon be constructing the facilities.

6.6 Conclusion

Hopefully, the following ideas were gained from this analysis and evaluation of CM as used by GSA and HEW:

(1) Where measurable data were obtainable, CM appears to have performed up to its objective of reducing the time for project performance and producing a job which is completed within the budget.

(2) The use of the CM in the design phase is imperative if the concept is to be successfully applied.

(3) The quality of the CM firm and the level of effort devoted to a project is critical to the success of the job.

(4) The requirements the owner/project manager places on the CM must be explicit and definitive to ensure that both parties completely understand their responsibilities.

(5) The CM concept has not diminished, but actually increased the importance and responsibility of the owner/project manager's role in the procurement of new facilities by giving him more control throughout all phases of the project. Therefore, the owner/project manager must structure his organization so that it is

adaptable to the type of decision making required in an integrated design-construction environment.

(6) The success of CM projects is highly dependent on the availability of funds for design and construction at an early point in the process. Implementation of a CM system without providing a sufficiently adaptable financing structure could negate many of the positive aspects of using a CM.

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CHAPTER 7

CM SYSTEMS APPLIED TO NAVY CONTRACT CONSTRUCTION

7.1 General

The Navy's system for procurement of contract construction and the CM method of contracting have been discussed, as well as the performance record and problems of each system. This chapter will attempt to apply the various CM alternatives to the Navy's construction procurement system and to indicate possible results.

The material covered in Chapters 2 and 3 becomes critical at this point, because each alternative must be presented in light of how it will affect the ability of the Navy to accomplish its goals and objectives. NAVFAC's military construction program supports the goals and objectives of the Navy and other defense agencies. Any alternative which does not improve some aspect of this supporting function is not acceptable.

For "real world" application, the resources and constraints of the environment must be imposed on these alternative systems. The four areas of the environment discussed in Chapter 2 (military, public, NAVFAC's organization, and construction industry) should be kept in mind when examining these alternative models, in order to predict the system-wide effects.

7.2 Configuration Of The Procurement Systems

7.2.1 System Dimensions and Components

There are three dimensions critical to the design of an alternative procurement system for the Navy. Those three dimensions are:

(1) The CM Concept

(2) The Project Manager Organization

(3) The Cyclical Strategy

7.2.1.1 Types of CM Concepts

CM concepts, which mean the form in which CM services are provided, will be segmented as follows for the purposes of presentation:

(1) "Pure" CM (often called Professional CM). Under this approach the CM provides a full range of services throughout design and construction, and no financial risk is assumed by the CM.

(2) Guaranteed Maximum Price CM. With this approach the CM provides a full range of services throughout design and construction, and also guarantees a ceiling price which the project cost will not exceed.

(3) Construction Consultant. This firm provides construction input to the design phase only as a consultant.

(4) In-House CM. CM services provided by a project team of NAVFAC personnel.

(5) Existing System. No provision is made for CM services.

7.2.1.2 Types of PM Organizations

"Project manager organization" refers to how NAVFAC would organize for the use of CM services. It has been noted in previous chapters that the provision of an owner's representative or project manager with considerable decision-making authority is a necessary ingredient for the success of the system. This presentation will only be concerned with the characteristics of the project manager's position itself, and not broad organizational modification of NAVFAC and its EFD's. All project manager systems will be considered to use the other element of NAVFAC's functional organization (i.e.,Design, Contracts and Construction Divisions) to support individual projects in a manner similar to the matrix organization discussed in Chapter 6. The various methods of organizing the project manager functions are as follows:

(1) Existing PM. The PM organization as explained in Section 3.3.3.7 where the PM is responsible primarily for ensuring financial resources are provided as needed for various phases of the project.

(2) Task-Oriented PM. The PM organization used by GSA where one PM is assigned to one large project, and given the responsibility and authority for the accomplishment from conception to completion.

(3) Centralized PM. This is expansion of the structure used by the Existing PM above where the PM is located in the EFD and is responsible for a number of projects of various sizes, except that now the PM has more responsibility and authority for project decision-making.

(4) ROICC PM. This PM is the ROICC or one of his assistants located at the project site. This PM may also have other projects of various sizes in progress. This PM is given the overall authority over project decision-making. He must now be concerned with the design phases, as well as with the construction. The contractual authority remains with the OICC which is normally the Commander of the Engineering Field Division.

(5) On-Site - OICC. This PM arrangement is an extension of (4) above. The PM is the existing ROICC or one of his assistants, but now the PM is given the contractual authority to award all contracts in connection with the project, even though he may utilize the personnel in the EFD contracts division for administrative purposes.

7.2.1.3 Types Of Cyclical Strategies

The cyclical strategy determines how to synchronize the design and construction with the planning and programming cycle discussed in Chapter 3. Since construction contracts cannot be awarded until after the authorization of the project and the appropriation of funds by the Congress, the options are rather limited. Knowledge of this planning and programming cycle is necessary to understand how CM models will interact with the Navy system. However, the detailed analysis and recommended modifications to the Shore Installations Facilities Planning and Programming System, and the executive and legislative budget reviews are not within the scope of this thesis. Therefore, the planning and programming cycle shall be

considered to be fixed, and the design and construction cycle variations shall be imposed on it. This approach seems to be logical, since the method of the thesis is to make an exploratory study on the suitability of CM for the Navy or graphically stated, the first pass through the systems analysis model presented in Section 1.10. Follow up studies represented by subsequent passes through the systems model would have to address modifications to the system of planning and programming and the process of budget review and approval in addition to just considering a new approach to design and construction.

The following cyclical strategies were conceived for application of CM to existing planning and programming process:

(1) Early Design. This is actually the commencement of design as it is presently accomplished, with the bulk of the MILCON program projects being released for design after the results of the Navy Military Construction Review Board (NMCRB) are received. Presently, this occurs nearly two years before construction funds are appropriated.

(2) Delayed Design. This is the commencement of design approximately 6 to 12 months prior to the anticipated appropriation of funds, but not until the budget has gone to the President. This was actually the point in time that NAVFAC commenced design on MILCON projects a few years ago.

(3) Late Design. This is the commencement of design after the projects have all been authorized and funds appropriated by Congress.

Using these three configurations, the timing of construction becomes dependent on when the funds are received and what type of CM arrangement is used.

7.2.2 Combinations Of The System Components

Given these three dimensions, with each containing a variety of alternative approaches, it becomes evident that a large number of combinations exist. This type of situation could be appropriately treated through the use of a morphological analysis. This method singles out

the most important dimensions of a problem, and then examines all the relationships among them.[1] In the previous subsection, three dimensions were singled out and alternative means of satisfying each were listed. The combination of these is graphically shown in Fig. 7.1, so the resulting combinations number 75 (5 x 5 x 3). One combination will be recognized as the existing system, for in any systems analysis the existing system is nearly always one alternative. Other combinations appear unworkable after a quick examination of the three components. Some examples are:

(1) When using a CM firm such as in the Pure CM and GMP-CM approaches, it would be unworkable to go with the Existing PM arrangement since the design-construction integration performed by the CM needs to be matched by a PM set-up which provides more coordination between phases as well;

(2) When using In-House CM where NAVFAC personnel would perform the CM function describedin Chapter 4, it would be unnecessary to have Task and Site-Oriented PM organizations since the In-House CM people could handle many of the PM responsibilities as well as the CM function;

(3) When procuring construction in the traditional manner, it would be unnecessary to have more elaborate PM organizations than presently exist since design and construction are separate and distinct functions, and less process integration is required. Thus, the value of a more sophisticated PM organization would probably provide little return for the resources invested in it;

(4) When using the traditional method to procure construction, it would be unwise to use the Late Design Cycle, where design does not commence until the construction funds are available;

(5) When using a Construction Consultant in the design phase of a project, more emphasis on the PM function may be appropriate; however, not to the extent that the On-Site-OICC concept would be required. In this case only one contract would still be awarded in a traditional manner to the lowest bidding general

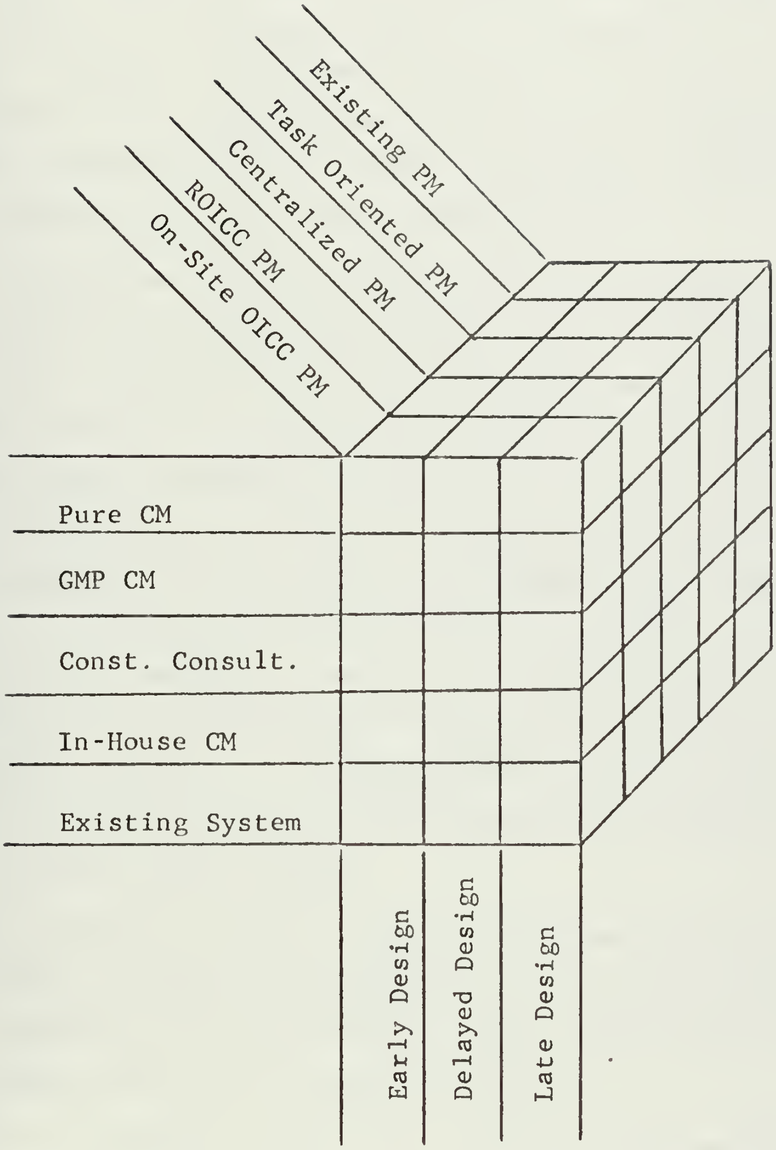

Fig. 7.1. Morphological Analysis Model.

contractor. Therefore, the On-Site-OICC PM, which is designed to allow award and total administration of contracts at the local level, would serve no purpose.

When comparing various CM concepts with PM organizations, the "Task," "ROICC," and "On-Site-OICC" PM's appeared to be acceptable with the "Pure" and GMP - CM systems regardless of cyclical strategy. On the other hand, the Construction Consultant and In-House CM approaches are more compatible with the Existing PM and the Centralized PM organizations regardless of the cyclical strategy used.

The problem of which of the three PM strategies to use with the Pure and GMP-CM approaches then becomes one of practicality. Task PM systems call for a full time PM and perhaps a small staff dedicated to one project and that one alone. Even though GSA uses this task type-PM, it becomes readily apparent to this writer as a CEC officer himself that NAVFAC certainly does not have the officer assets and probably not the civilian assets to devote a full time PM to all large (over $5 million) projects. On certain occasions this may be possible, but not if a decision rule is applied to use CM on all projects over $5 million. The ROICC and On-Site-OICC PM's are basically adaptations of the existing ROICC office. It is proposed that this adaptation strategy is the best approach for use with full service CM provided by private firms for the following three reasons:

(1) It recognizes the fact that at the same location numerous projects, which are below the economical size for CM treatment, are being performed in the traditional manner, and as such they must be administered in the established way.

(2) It is personnel efficient by not requiring the full time commitment of people exclusively to one project.

(3) It is site-oriented. Throughout the text of this entire paper, the site-orientation of the CM has been stressed. From the market study to the supervision and inspection of the miltiple contractor's

work, the success of the CM is closely related to the work he does at the project site. In many cases the A-E's office is even in the community near the site. Thus, what better place to work with and observe the performance of the CM than at the site itself? Under the On-Site-OICC PM arrangement, even the bid openings can be held in the local area.

When considering the more plausible of the 75 different models, the comparisons and tradeoffs and the advantages and disadvantages of various combinations could take a tremendous effort to develop as well as to comprehend. It is also a comparative effort which is subject to little quantification. As a result, Table 7.1 was developed to make a comparison of the 14 most logical combinations of CM concepts, PM organizations and cyclical strategies; and to compare them on their predicted performance on each aspect of a project and on the possible impact they would make on the NAVFAC military construction program as a whole. Figure 7.2 is provided to complement Table 7.1 by showing how each of the models reacts with the military construction program cycle in terms of when designs begin and finish, and when construction starts and completes.

The first six models, A through F, are systems which use private firms to perform the CM function. The PM organization used in Models A-F is the On-Site-OICC project manager, which the writer considers superior to all others for use on projects with a private CM. However, it should be pointed out that use of the ROICC PM in Models A-F will produce almost the same results on the aspects of the project and the military construction program as the On-Site-OICC PM does. Thus, the reader should be aware that in the first six project strategy models, two PM models are quite appropriate. The On-Site-OICC PM was considered slightly more desirable than the ROICC-PM because it appears to be a little more responsive in decision-making concerning contracts. Taking bids, awarding contracts, and reviewing and approving change orders locally would seem to be more effective when done near the site, since there will be a number of small and moderate contracts rather than one big one. However, even on GSA's large CM projects with their task-oriented PM's, the regional PBS contracts division takes bids, awards and

TABLE 7.1. CONSTRUCTION PROCUREMENT MODEL COMPARISON CHART

ASPECT OF THE PROJECT \ MODEL	A On-Site OICC PM Early Design Cycle	B On-Site OICC PM Delayed Design Cycle	C On-Site OICC PM Late Design Cycle	D On-Site OICC PM Early Design Cycle	E On-Site OICC PM Delayed Design Cycle	F On-Site OICC PM Late Design Cycle	G Consult. Existing PM Early Design Cycle	H Consult. Centralized PM Early Design Cycle	I Consult Existing PM Delayed Design Cycle	J Consult Centralized PM Delayed Design Cycle	K In-House CM Existing PM Delayed Design Cycle	L In-House CM Centralized PM Delayed Design Cycle	M In-House CM Existing PM Late Design Cycle	N In-House CM Centralized PM Late Design Cycle
1 Selection of the firm to manage the construction work (schedule, supervise, direct, coordinate contractors)	NAVFAC may select firm on the basis of (1) qualifications, 2) proposed plan for integration of design and construction, (3) proposed fee for services						NAVFAC selects the lowest responsive, responsible bidder on the contract package for the entire construction work				NAVFAC selects among its own personnel, military and civilian, the most qualified individuals to staff a CM organization. Due to the present tight staffing and a limited level of superintendence expertise, this method may have limited applications			
2. Constructibility inputs into design	CM performs. Highly critical to generating project cost savings.						Consultant performs. Highly critical to generating project cost savings. Since construction to be performed by general contractor on a lump sum basis, construction inputs may be less effective because consultant will not be directing the work in the field				Navy CM personnel performs. Highly critical to generating project cost savings			
3 Construction market inputs	CM performs, however, early design means study less relevant	CM performs. Highly critical to generate project cost savings		CM performs however, early design means study less relevant	CM performs. Highly critical to generate project cost savings		Consultant performs. However, early design means market study less relevant; also since construction is to be performed by general contractor, market study less critical because no packaging decisions are required		Consultant performs. Since construction to be performed by general contractor, market study less critical because no packaging decisions are required		Navy CM personnel performs. Highly critical to generating project cost savings			
4. Estimating	CM performs all estimating. A-E contract should reflect this, however, A-E must concur in estimates because he is still obligated to redesign at no extra cost to government if bids are too high			CM performs estimating in design phase. A-E contract should reflect this, however, A-E must concur in estimates because he is still obligated to redesign at no extra cost to government if bids are too high. NAVFAC must estimate change orders since changes can increase the GMP			Consultant performs for design phase and in some cases for change orders				Navy CM personnel or A-E may estimate project			
5 Design's relevancy to potential user's needs and latest technology	Least relevant since design & basic decisions made up to 2 yrs before start of construction	More relevant since basic design decisions are not required until 6 to 12 mos before construction start	Most relevant since this model produces shortest design-construct cycle time	Least relevant since design & basic decisions made up to 2 yrs before start of construction	More relevant since basic design decisions are not made until 9 to 12 mos before construction starts		Least relevant since basic design decisions made up to 2 yrs before start of construction		Slightly more relevant since basic design decisions made up to 18 mos before start of construction		Somewhat relevant since basic design decisions made 6 to 12 mos before construction starts		Most relevant since this model produces shortest design-construct cycle time	
6 Supporting documentation for DOD budget examination and Congressional hearings	Provides the most complete information to draw from	Information must come from in-house preliminary planning		Provides the most complete information to draw from	Information must come from in-house preliminary planning		Provides the most complete information to draw from		Information must come from in-house preliminary planning					
7 Design errors and omissions	Least risk of omissions and errors since design at or near completion prior to start of construction	Some risk of errors since 6 to 12 mos of design done prior to construction start	Most risk of omissions and errors since construction started with least amount of design done	Least risk of omissions and errors since design at or near completion prior to start of construction. CM may bear part of this risk	Some risk of omissions and errors since 9 to 12 mos of design done prior to construction start. CM may bear part of this risk		Least risk of omissions and errors since design completed prior to bidding on lump-sum general contract				Some risk of omissions and errors since 6 to 12 mos of design done prior to start of construction		Most risk of omissions and errors since construction started with least amount of design done	
8 State of design at start of construction	Design at or near completion at start of construction; constrained by funds availability, not design	Start of construction 6 to 12 mos after start of designing; constrained by funds availability, not design	Requires least design work to start construction: only 4 to 6 mos	Design at or near completion at start of construction. Constrained by funds availability, not design	Requires 9 to 12 mos of design work to start construction because design must be fairly detailed for CM to give a GMP		Design complete at start of construction				Start of construction 6 to 12 mos after start of design. Constrained by funds availability, not design		Requires least design work to start construction: only 4 to 6 mos	
9 Competition for construction contracts	Competition should be quite high if contracts are bid within a reasonable time before the work is to begin and if market factors are taken into consideration. Funds availability determines the earliest time when construction contracts can be awarded, however, multiple contracts should not be put out to bid just because the funds are available, but rather close to when the work is needed. More bidders will be financially able to bid and to obtain bonding since the job is segmented						Competitiveness should be similar to existing conditions in bidding for large NAVFAC projects since only one construction contract is awarded				Competition should be quite high if contracts are bid within a reasonable time before the work is to begin and if market factors are taken into consideration. Multiple contracts should not be put out to bid just because the funds are available, but rather close to when the work is needed. More bidders will be financially able to bid and to obtain bonding since the job is segmented			
10 Contract administration workload	Significant increase in paperwork over the traditional method because of 20 construction contracts vs. one contract and also the addition of the CM's contract. Even though there will be more advertisements, bid openings, contract awards, progress payment and change order requests, the workload should not increase by a factor of 20 since the CM will assist to some degree in potential bidder identification, briefing potential bidders, initially screening payment and change order requests.						Should remain stable since there is only one construction contract except for the administration of the consultant's contract				Significant increase in paperwork over traditional method because of approximately 20 construction contracts vs. one			

TABLE 7.1 (cont.)

ASPECT OF THE PROJECT \ CM MODEL	A PURE CM On-Site-OICC PM Early Design Cycle	B PURE CM On-Site-OICC PM Delayed Design Cycle	C PURE CM On-Site-OICC PM Late Design Cycle	D GMP CM On-Site-OICC PM Early Design Cycle	E GMP CM On-Site-OICC PM Delayed Design Cycle	F GMP CM On-Site-OICC PM Late Design Cycle	G Const. Consult Existing PM Early Design Cycle	H Const. Consult Centralized PM Early Design Cycle	I Const. Consult. Existing PM Delayed Design Cycle	J Const. Consult Centralized PM Delayed Design Cycle	K IN-HOUSE CM Existing PM Delayed Design Cycle	L IN-HOUSE CM Centralized PM Delayed Design Cycle	M IN-HOUSE CM Existing PM Late Design Cycle	N IN-HOUSE CM Centralized PM Late Design Cycle
11. Value Engineer Inputs by Contractors	Should increase since contracts are now directly with the multiple contractors (previously subcontractors). Contractors can deal directly with government rather than going through general contractor level. These inputs would come from the prebid conferences after which addenda to the bid package may be issued, or after contract award whereby contractors would share in savings without having to split with a general contractor. CM's may not share in any cost saving since they worked on design (this is prohibited by ASPR).						Should remain at about present level				Should increase since contracts are now directly with the multiple contractors (previously subcontractors). Contractors can deal directly with government rather than go through general contractor layer. These inputs would come through the prebid conferences after which addenda to the bid package may be issued or after contract award whereby contractors would share in savings without having to split with a general contractor			
12 Budget Control	Requires the most sophisticated and close attention to budget control through accurate estimating, constructability inputs and astute interpretation of the market since contract package overruns can only be accepted or redesigned and rebid. EFD central management of contingency funds and statutory escalation limits allow NAVFAC some flexibility in coping with problem projects			Since the CM gives a GMP budget control as far as the PM is concerned it can be less sophisticated because the Navy is protected from a large overrun. However, PM must still be concerned with scope changes, changes in designs, unforeseen conditions that can lead to increases in the GMP. In the case of contract package overruns CM may have more options open to them to solve problem. EFD central management of contingency funds and statutory escalation limits make the GMP less of a necessity			Budget control apparently guaranteed by low lump sum bid which falls at or below the budget amount before construction begins. PM must be concerned with change orders creating an overrun as in existing system. However, constructability inputs should reduce change orders due to deficient plans and specifications				Requires close attention and the most sophisticated budget control system performed through accurate estimating, constructability inputs, and astute interpretation of the market since contract package overruns can only be accepted or redesigned and rebid. In some cases in-house forces could be used to do work on packages with no acceptable bids. EFD central management of contingency funds and statutory escalation limits allow NAVFAC some flexibility in coping with problem projects			
13. Change Orders	Dollar volume should be low since design is at or near completion. Number should be high due to large number of contracts. Construction inputs to design should also minimize dollar volume. However, risk of user changes is higher	Dollar volume should be moderate since design is substantially complete. Number should be high due to large number of contracts. Construction input to design should minimize dollar volume	Dollar volume should be highest since design is in least complete state. Number should be high since large number of contracts. Construction input to design should minimize dollar volume	Dollar volume should be low since design is at or near completion. Number should be high due to large number of contracts plus change orders to GMP. Construction input to design should minimize dollar volume. However, risk of user changes higher	Dollar volume should be moderate since GMP will not be determined until design is substantially complete. Number should be high due to large number of contracts plus change orders to GMP. Construction input to design should minimize dollar volume.		Construction input to design should reduce number and dollar volume. However, the risk of user changes higher		Construction input to design should reduce number and dollar volume		Dollar volume should be moderate since design is substantially complete. Number should be high due to large number of contracts. Construction input to design should also minimize dollar volume		Dollar values should be highest since design is in least complete state. Number should also be high due to large number of contracts. Construction input to design should also minimize dollar volume.	
14 Continuity of Design/CM/PM Personnel	Least chance of continuity since design and construction time is long	Reasonable chance of continuity since design starts 4 to 12 mos prior to start of construction	Best chance of continuity since design and construction time the shortest	Least chance of continuity since design and construction time is long	Reasonable chance of continuity since design starts 4 to 12 mos prior to start of construction.		Reasonable chance of continuity since consultant used in design phase only. However, breaks in design may reduce the chances. Continuity less critical since design and construction are not phased		Good chance of continuity since consultant used in design phase only. Continuity less critical since design and construction are not phased		Reasonable chance of continuity since design starts 5 to 12 mos prior to start of construction and since NAVFAC can directly control CM personnel assignment		Best chance of continuity since design and construction time the shortest and since NAVFAC can directly control CM personnel assignment	
15 Quality Control (QC)	CM would perform QC including initial review of shop drawings and material submittals. NAVFAC field representatives would maintain surveillance over CM QC and project in general			NAVFAC inspectors would perform QC since CM now has financial interest in project. However, if the CQC philosophy is applied perhaps the CM could perform the QC under the requirements of the QC program			QC would be performed by the general contractor under the existing CQC program, or it could be performed by NAVFAC inspectors				Navy CM organization would perform its own QC			
16. Scheduling/Management Information and Control Systems	Requires the most sophisticated system as far as NAVFAC is concerned, since NAVFAC assumes the overall risk. Systems utilized under these models should provide the most accurate and realistic feedback to the PM to allow early identification of problem areas, responsive and reliable answers to superiors and future occupants of the facility, decisive occupancy planning, etc. Due to criticality of system to PM, NAVFAC may want CM's to use a standard system similar to GSA's			Requires a less sophisticated system for the purposes of the PM since the CM assumes the risk for project cost. System should still produce more accurate and realistic information than systems using a general contractor. Since CM is contractually responsible for costs over GMP, NAVFAC may have less justification in specifying what system must be used. However, it would be advantageous to NAVFAC for a standard system such as GSA's to be used			Not highly critical to PM since construction is performed in traditional manner. Information provided by general contractor is incidental to his primary function and accuracy may suffer as a result.				Requires the most sophisticated system as far as NAVFAC is concerned since NAVFAC assumes the overall project risk. Systems utilized under these models must provide accurate and realistic information to the CM team for directing the work dealing with problem areas and responding to questions on project progress and cost. NAVFAC must use a standard Navy-wide system.			

TABLE 7.1 (cont.)

ASPECT OF THE PROJECT / CM MODEL	A: PURE CM On-Site OICC PM Early Design Cycle	B: PURE CM On-Site OICC PM Delayed Design Cycle	C: PURE CM On-Site OICC PM Late Design Cycle	D: GMP CM On-Site OICC PM Early Design Cycle	E: GMP CM On-Site OICC PM Delayed Design Cycle	F: GMP CM On-Site OICC PM Late Design Cycle	G: Const. Consult. Existing PM Early Design Cycle	H: Const. Consult. Centralized PM Early Design Cycle	I: Const. Consult. Existing PM Delayed Design Cycle	J: Const. Consult. Centralized PM Delayed Design Cycle	K: IN-HOUSE CM Existing PM Delayed Design Cycle	L: IN-HOUSE CM Centralized PM Delayed Design Cycle	M: IN-HOUSE CM Existing PM Late Design Cycle	N: IN-HOUSE CM Centralized PM Late Design Cycle
17 Cost and Financing of CM	CM must be funded with preliminary planning funds in the design phase and construction funds in the building phase. Cost of CM should be in the neighborhood of 2-3% of estimated construction cost excluding work done by CM's own forces. Procedures will be needed to control reimbursable expenditures particularly of general conditions work		CM is funded with construction funds. Cost of CM is 2-3% of estimated construction cost excluding work done by CM's own forces. Procedures will be needed to control reimbursable expenditures particularly on general conditions work	CM must be funded with preliminary planning funds in the design phase and construction funds in the building phase. Cost of CM should be in neighborhood of 4-5% of estimated construction cost excluding work done by CM's own forces. Higher cost reflects CM's cost of bonding and cost of risk. Procedures will be needed to control reimbursable expenditures particularly on general conditions work		CM is funded with construction funds. Cost of CM is 4-5% of estimated construction cost excluding work done by CM's own forces. Higher cost reflects the CM's cost of bonding and cost of risk. Procedures will be needed to control reimbursable expenditures particularly on general conditions work	Consultant must be funded with preliminary planning funds. Cost of consultant should be in the neighborhood of 0.5-1% of the estimated construction cost				CM personnel and operations funded through government supervision, inspection and overhead funds. Even though cost should be less than when using private CM firm, the availability of NAVFAC personnel to staff In-House CM organization may be problem			
18 Government Supervision Inspection and Overhead Costs (SIOH)	SIOH would probably remain at about the same level though the components of the cost may change. There may be a reduction of on-site NAVFAC field construction representatives and a corresponding increase in office contract administration (i.e., paperwork)			SIOH would probably remain at the same level. More office contract administration would be required and perhaps somewhat less PM control would be needed since the CM has a GMP. NAVFAC construction representative would be required for field inspection or surveillance of CM QC			No change to SIOH costs.				SIOH would increase to cover cost of NAVFAC CM personnel.			
19 NAVFAC Organizational Response to System	The functional divisions of the EFD's (i.e., design, contracts, construction) must be given special attention to the timely processing of work for CM projects especially where the design and construction phases are greatly overlapped. The PM must have the authority to make timely decisions and the OICC-PM approach helps achieve that requirement.						These projects treated in routine manner.	PM organization enhances the chance that the full intent of construction inputs to design will be carried over into building phase	These projects treated in routine manner	PM organization enhances the chance that the full intent of construction inputs to design will be carried over into building phase	Project must receive special attention from EFD. divisions	Project must receive special attention from EFD divisions. PM organization should provide mechanism to achieve consistent treatment of project by EFD.	Project must receive special attention from EFD divisions	Project must receive special attention from EFD divisions. PM organization should provide mechanism to achieve consistent treatment of project by EFD
20 Project warranty	Each construction contractor would warrant his own work. However, failures or discrepancies not easily attributed to one contractor could ultimately become NAVFAC's problem. Courts will ultimately settle this question			The CM warrants his work in a similar manner to the general contractor			The warranty is responsibility of the general contractor				Each construction contractor would warrant his own work. However, failures or discrepancies not easily attributed to one contractor could ultimately become NAVFAC's problem.			
21. Overall Project Risk	NAVFAC assumes overall project risk. Each contractor assumes risk for his portion of the project. CM assumes very little if any, risk			CM assumes overall project risk for costs exceeding the GMP and for timely completion if liquidated damages are specified in the CM's contract. Risks of unforeseen site conditions and changed requirements are still the responsibility of NAVFAC. If GMP is in danger of being exceeded CM may search for changes to increase GMP. Thus, in actuality NAVFAC may end up sharing or assuming most of the risk.			General contractor assumes overall project risk for cost and time overruns. Risks of unforeseen site conditions, changed requirements, design omission and errors are still the responsibility of NAVFAC. Contractor in financial difficulty may put NAVFAC on defense by trying to maximize revenues from change orders. Thus, in actuality NAVFAC may end up sharing the project risk.				NAVFAC assumes overall project risk. Each contractor assumes risk for his portion of the project			
22 Compliance with Armed Services Procurement Regulation (ASPR)	CM models in compliance with ASPR			CM models in compliance with ASPR provided that CM's do not share in savings below the GMP. ASPR does not permit participants in the design phase to share in cost savings			Construction consultant models in compliance with ASPR				In-House CM models in compliance with ASPR.			

TABLE 7.1 (cont.)

IMPACTS ON THE GOALS AND ENVIRONMENT OF THE NAVY CONSTRUCTION PROGRAM \ CM MODEL	A PURE CM On-Site-OICC PM Early Design Cycle	B PURE CM On-Site-OICC PM Delayed Design Cycle	C PURE CM On-Site-OICC PM Late Design	D GMP CM On-Site-OICC PM Early Design Cycle	E GMP CM On-Site-OICC PM Delayed Design Cycle	F GMP CM On-Site-OICC PM Late Design Cycle	G Const. Consult. Existing PM Early Design Cycle	H Const. Consult Centralized PM Early Design Cycle	I Const. Consult Existing PM Delayed Design Cycle	J Const. Consult. Centralized PM Delayed Design Cycle	K IN-HOUSE CM Existing PM Delayed Design Cycle	L IN-HOUSE CM Centralized PM Delayed Design Cycle	M IN-HOUSE CM Existing PM Late Design Cycle	N IN-HOUSE CM Centralized PM Late Design Cycle
23 Time for Completion of $5-10 Million Project Ranked in Order of Which Model Completes the Project Soonest. Refer to Fig 7 2. (Assumptions: time for design is 14 mos and construction is 24 mos for all methods taken from Table 5 1 - avg. for large Navy projects)	25 mos. - one of five tied for #1	25 mos. - one of five tied for #1	28 mos. - one of four tied for #8	25 mos. - one of five tied for #1	28 mos. - one of four tied for #8	36 mos. - last, #14	26 mos. - tied for #6/7	25 mos. - one of five tied for #1	29 mos. - tied for #12	28 mos. - one of four tied for #8	26 mos. - tied for #6/7	25 mos. - one of five tied for #1	29 mos. - tied for #12	28 mos. - one of four tied for #8
24 Design/Construction Cycle Time Ranked in Order of Which Model Allows Shortest Cycle Time. Refer to Fig 7 2	48 mos. - one of three tied for #11	31 mos. - tied for #4/5	28 mos. - tied for #1/2	48 mos. - one of three tied for #11	34 mos. - tied for #7/8	34 mos. - tied for #7/8	49 mos. - ranked #14	48 mos. - one of three tied for #11	41 mos. - ranked #10	40 mos. - ranked #9	32 mos. - ranked #6	31 mos. - tied for #4/5	29 mos. - ranked #3	28 mos. - tied for #1/2
25 Cost of Large Projects (Note: all but Model F should produce lower costs than traditional technique) Ranked in Order of Which Produces Lowest Cost.	Ranked #8 CONTRIBUTORS: • Constructability inputs to design • Unconstrained CM • Allows earliest start of construction • Firm that makes inputs to design directs construction DETRACTORS: • Market information to design may be outdated • High risk of user changes	Tied for #1/2 CONTRIBUTORS: • Inputs to design current • Unconstrained CM • Allows earliest start of construction • Firm that makes inputs directs construction	Tied for #4/5 CONTRIBUTORS: • Inputs to design very current • Unconstrained CM • Firm that makes inputs to design also directs construction DETRACTORS: • Construction will start 6 mos after funds available (inflation problem)	Ranked #9 CONTRIBUTORS • Constructability inputs to design • Firm that makes inputs to design directs construction • CM has financial responsibility to meet budget • Allows earliest start of construction DETRACTORS: • CM will charge NAVFAC for risk assumption • Market input to design may be outdated • High risk of user changes	Ranked #7 CONTRIBUTORS: • Inputs to design current • Firm that makes inputs to design directs construction • CM has financial responsibility to meet budget • Construction can begin fairly soon after funds available DETRACTORS: • CM will charge NAVFAC for risk assumption	Ranked #14 CONTRIBUTORS: • Inputs to design very current • Firm that makes inputs to design directs construction • CM has financial responsibility to meet budget DETRACTORS: • will produce latest start of construction (inflation problem) • CM will charge NAVFAC for risk assumption	Ranked #13 CONTRIBUTORS: • Constructability inputs to design • General contractor assumes financial risk DETRACTORS: • Firm that makes input to design does not direct construction • Construction cannot begin until design is complete • General contractor will charge NAVFAC for risk assumption and uncertainty in sub-bids • Market info to design less relevant • Less sophisticated PM system may prevent CM input from being efficiently passed to construction phase	Ranked #11 CONTRIBUTORS: • Constructability inputs to design • PM would ensure CM input passed to construction phase • General contractor assumes financial risk DETRACTORS: • Firm that makes inputs to design does not direct construction • Construction cannot begin until design is complete • General contractor will charge NAVFAC for risk assumption and uncertainty in sub-bids • Market info to design less relevant	Ranked #12 CONTRIBUTORS. • Inputs to design fairly current • General contractor assumes financial risk DETRACTORS: • Firm that makes input to design does not direct construction • Construction cannot begin until design is complete • General contractor will charge NAVFAC for risk assumption and uncertainty in sub-bids • Less sophisticated PM system may prevent CM input from being efficiently passed to construction phase	Ranked #10 CONTRIBUTORS: • Inputs to design fairly current • PM would ensure CM input passed to construction phase • General contractor assumes financial risk DETRACTORS: • Firm that makes inputs to design does not direct construction • Construction cannot begin until design is complete • General contractor will charge NAVFAC for risk assumption and uncertainty in sub-bids	Ranked #3 CONTRIBUTORS: • Inputs to design current • No cost of outside CM • Allows earliest start of construction • CM team that makes inputs to design also directs construction DETRACTOR: • Less sophisticated PM organization may provide less coordination at EFD	Tied for #1/2 CONTRIBUTORS: • Inputs to design current • No cost of outside CM • Allows earliest start of construction • CM team that makes inputs to design also directs construction	Ranked #6 CONTRIBUTORS: • Inputs to design very current • No cost of outside CM • CM team that makes inputs to design also directs construction DETRACTORS: • Construction will not start until 6 mos after funds available (inflation problem) • Less sophisticated PM organization may provide less coordination at EFD	Tied for #4/5 CONTRIBUTORS: • Inputs to design very current • No cost of outside CM • CM team that makes inputs to design also directs construction DETRACTOR: • Construction will not start until 6 mos after funds available (inflation problem)

TABLE 7.1 (cont.)

IMPACTS ON THE GOALS AND ENVIRONMENT OF THE NAVY CONSTRUCTION PROGRAM / CM MODEL	A PURE CM On-Site-OICC PM Early Design Cycle	B PURE CM On-Site-OICC PM Delayed Design Cycle	C PURE CM On-Site-OICC PM Late Design	D GMP CM On-Site-OICC PM Early Design Cycle	E GMP CM On-Site-OICC PM Delayed Design Cycle	F GMP CM On-Site-OICC PM Late Design Cycle	G Const. Consult. Existing PM Early Design Cycle	H Const. Consult Centralized PM Early Design Cycle	I Const. Consult. Existing PM Delayed Design Cycle	J Const. Consult Centralized PM Delayed Design Cycle	K IN-HOUSE CM Existing PM Delayed Design Cycle	L IN-HOUSE CM Centralized PM Delayed Design Cycle	M IN-HOUSE CM Existing PM Late Design Cycle	N IN-HOUSE CM Centralized PM Late Design Cycle
26 Construction Starts During Program Yr. As Defined by NAVFAC (Project is considered started when contracts for 50% of estimated project cost have been awarded) Goal is for 50% of Contracts in Terms of Dollar Volume to be Started Within Program Year	Since in both models bid packages will be ready for advertisement as soon as construction funds are authorized there is some chance of making goal. However, it would still be less than under traditional system. If design is at or near completion when construction funds become available advertising all bid packages at the beginning will decrease the benefits of using CM		Since many contracts are awarded as the work progresses there is little chance of awarding 50% within the program year.	Since all bid packages are available for advertisement when construction funds are received there is some chance of making goal. However, it is still less than traditional system. If all bid packages are advertised when construction funds are made available the benefit of using CM will be destroyed.	Since no bid packages will be ready for advertisement until at least 4 mos into program year the chances of making goal are slim.	Since no bid packages could be awarded until 10 mos into the program year there is no chance of meeting goal	All should achieve goal, perhaps even better than the existing traditional system since construction inputs to design and estimating by construction oriented people may reduce the incidence of bid openings which fail to receive an acceptable bid				Since many contracts are awarded as the work progresses there is less chance of awarding 50% during program year than under traditional system.		Since many contracts are awarded as the work progresses there is little, if any chance of awarding 50% within program year.	
27 Actual Construction Start in Terms of First Contract Awarded	Within 1 mo after funds are made available		Within 6 mos after funds are made available	Within 1 mo after funds are made available	Within 6 mos after funds are made available	Within 10 mos after funds are made available	Within 1-2 mos after funds are made available		Within 4-5 mos after funds are made available		Within 1-2 mos after funds are made available		Within 4-5 mos after funds are made available	
28 Design Breakage (designs which do not get constructed because project does not receive authorization, funding or it is no longer required)	No effect on existing level of design breakage	Should reduce existing level of design breakage	Should nearly eliminate design breakage	No effect on existing level of design breakage	Should reduce existing level of design breakage	Should nearly eliminate design breakage	No effect on existing level of design breakage		May reduce existing level of design breakage		Should reduce existing level of design breakage		Should nearly eliminate design breakage	
29 Behavioral Reaction of NAVFAC Personnel, A-E's and Contractors	NAVFAC personnel may misconstrue the CM as one who is taking over a traditional NAVFAC function and react negatively. A-E may feel threatened also. Ex-subcontractors may experience some uncertainty since they contract directly with NAVFAC rather than a general contractor. General contractors who do not practice CM will be negative						A-E's may feel threatened with consultant participating in design. Otherwise little, if any, negative reaction will result with other participants in the process, since no significant organizational change has been made				A-E's may react negatively to greater NAVFAC participation in their design. Ex-subcontractors may experience some uncertainty since they contract directly with NAVFAC rather than a general contractor. General contractors not practicing CM's will react negatively. Little or no impact on NAVFAC personnel behavior			
30 Participation of Small Business Contractors in Large NAVFAC Projects	Dividing project into separate contracts should allow more contracts to be designated as "small business set aside" and thus increase their participation						No effect on participation by small business contractors				Dividing project into separate contracts should allow more contracts to be designated as "small business set aside" and thus increase their participation			
31. Planning, Programming, Implementation Cycle	No effect	Start of design at a later date with little or no adverse effect on the start or completion of construction allows possible reductions in planning and programming time	No effect		Start of design at a later date with little effect on start or completion of construction allows possible reductions in planning and programming time	Start of design at late date allows possible reductions in planning and programming time, but late start and completion of construction offsets the benefits	No effect on cycle		Start of design at a later date with little or no adverse effect on the start or completion of construction allows possible reductions in planning and programming time					
32 The Practice of CM in the Construction Industry	These models should increase the practice of CM in the construction industry						These models may increase the practice of CM somewhat since active CM firms will perform the consulting service				Since CM done In-house no effect will be made on the practice of CM			

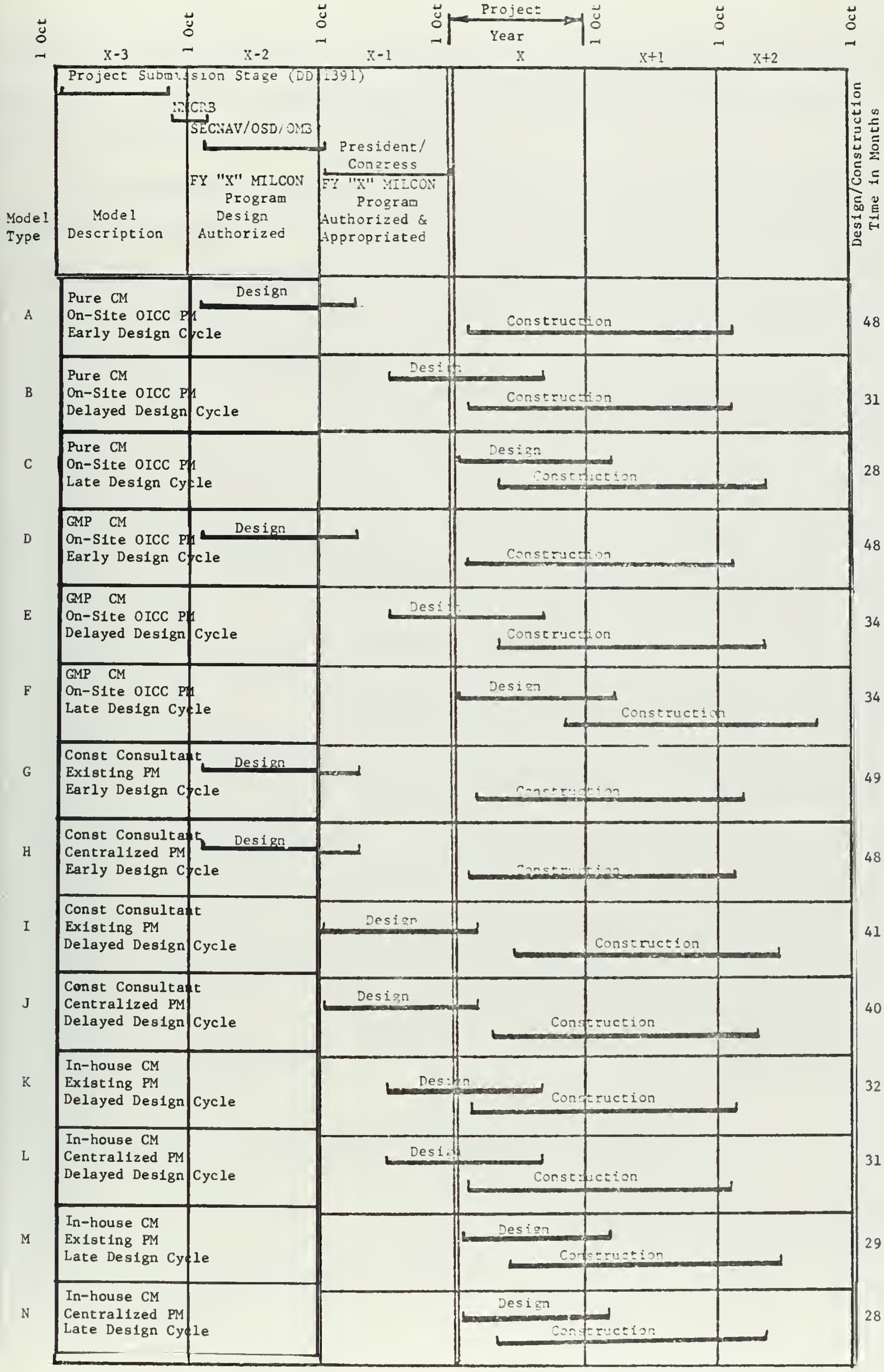

Fig. 7.2. Design - Construct Phasing Chart

handles the paperwork on all the construction contracts. Therefore, the ROICC-PM organization should not be discarded as impractical just because it does not appear in Table 7.1.

In reference to Models K through N, the in-house CM systems, the effects that these models have on the various aspects of the projects and the overall MILCON program are very similar to the ones caused by the Pure CM systems in Models A-C. However, NAVFAC may encounter difficulty in trying to make widespread application of this system on all large projects. First, use of the in-house system would require much more manpower, since NAVFAC would be assuming an additional responsibility not generally considered in its workload. The task of construction superintendence - the scheduling, coordinating, directing multiple contractors - alone would require a significant increase in human resources dedicated to the project. Since NAVFAC has been seeking ways to stretch its own inspection manpower through techniques like Contractor Quality Control, it seems that widespread application of Models K-N would be impractical. Secondly, since NAVFAC lets contracts for nearly all major construction within the States, the expertise of construction superintendence for large, complex contract jobs has been developed in the private sector rather than in the Navy. NAVFAC has significant capabilities in project management and construction inspection to draw from; however, the existence of experienced construction superintendents within the Facilities Engineering Command is likely to be sparse. Thus, NAVFAC can perform its own CM on a few projects and the comments in Table 7.1 are applicable for those cases; however, the limitation of human resources prevents its widespread use.

7.3 Selecting Among Alternative Procurement Systems

Each of the models listed in Table 7.1 has its own set of positive and negative characteristics. However, a few models are worthy of special note, and they will be discussed here.

7.3.1 First Choice

The best of the CM alternatives as listed in Table 7.1 is the one designated as Model "B," Pure CM with On-Site-OICC PM in a Delayed Design cycle. This is the model where the CM has no financial risk in the project, the project management function is handled by NAVFAC from the job site, and design is commenced about 7-8 months prior to the receipt of the construction funds. The advantages this system offers are:

(1) It allows NAVFAC to have the discretion to pick the head constructor on the basis of his reputation and his proposed plan of accomplishment for the project, with consideration given to the cost of his services. People involved in federal government construction have long moaned about selecting the low bidder, regardless of his character and reputation. CM provides NAVFAC the opportunity to select the construction leadership while still remaining within the rules requiring competitive bids for all the construction work itself.

(2) The CM will have to live with his constructability inputs made in the design phase when he has to direct their installation in the construction phase. This should eliminate the making of suggestions which are untried or impractical, which were made just to impress the PM with the great inputs the CM is making to the project.

(3) It allows market inputs which are effective because the initial market study is made only 7 to 8 months prior to the start of construction.

(4) With the design commenced only 7 months prior to start of construction, the design still has a good chance of being relevant to the users' needs, which can change quickly in the Navy's environment. The design can also reflect the latest technological considerations.

(5) By using multiple contractors and bidding each work package a short time before its respective portion of the job is required, the uncertainty subcontractors have to account for in their bids is

considerably reduced. This will have the effect of reducing the cost as well.

(6) A design-construction cycle time of 31 months for projects over $5 million improves the prospects of personnel continuity through the entire process. This includes CM, PM, and A-E personnel.

(7) It allows for a good answer to the quality control dilemma. Since quality control is provided by the CM, this reduces the workload on Navy inspectors. Also, since the CM has no financial interest in the project, the CM's inspectors can be expected to act in the interests of NAVFAC rather than a contractor.

(8) It allows NAVFAC to select a CM who is skilled in using computerized design-construction management information and control systems, and network scheduling to provide information concerning such things as projections for: (a) milestone points in the design or construction; (b) dates when government furnished equipment is required; and (c) the usable completion date. This type of data has always been important to NAVFAC, and under this model the provision of information systems is a primary duty of the CM. Under the existing system, even the limited information the general contractor has to provide, such as an initial CPM schedule, is in reality a secondary requirement of his contract. As a result, it gets secondary treatment.

(9) It should produce the lowest total project cost, especially if the CM's fee less any reimbursable work done by its construction forces remains in the range of 2 to 3 percent. In referring to Fig. 4.13, it can be seen that a general contractor charges 3 to 5 percent of subcontract costs for management, 15 percent of his own forces' portion of the work for profit, contingency, and overhead. CM fees in the range experienced by GSA should produce projects at a cost less than if the jobs were accomplished under the existing traditional approach. When one adds the cost savings generated by the CM's construction and market inputs to the design, the cost of the project should be below the traditional

approach. Most users of CM services claim the major cost savings are created by inputs to the design.

(10) Starting the design only 7-8 months before the appropriation of construction funds minimizes "design breakage," since projects have survived all but the Congressional review.

(11) One of the most important advantages is that starting the design only 7-8 months before the appropriation of construction funds would allow some possible reductions in the planning and programming, cycle, with construction still completing at the earliest possible date. Referring to Fig. 7.2, it can be seen that a user activity's wait for a needed facility is determined to a greater extent by the planning and programming time, rather than by the length of the design and construction period. As noted previously, analysis of the planning and programming cycle is not within the scope of this thesis, since it could be the topic of a lengthy study as well; however, use of this model with its later design start date would remove one requirement for an early start to the process of turning facility needs into completed construction. The net effect of a reduced planning and programming cycle on the "front end" of the overall project cycle would be a facilities production system that is more responsive to the Navy's current requirements.

The disadvantages that Model "B" would present are:

(1) Since the design development could not begin until a later date this system would not provide the extensive supporting documentation now provided by a design which reaches the 30 percent stage well before the Congressional hearings. This writer understands that NAVFAC is currently attempting to restructure the format of the documentation which is presented to Congress, to eliminate a number of details about the technical aspects of the project. If information such as the construction material to be used and quantities and cost breakdowns for details of the project could be eliminated, the need for extensive supporting documentation would diminish. In that case, EFD design divisions could then

provide program cost estimates which would probably be reliable as fairly detailed estimates made by A-E's at least eight months before construction bids can be taken. Congress then could concentrate on the real issues, like the validity of the facility requirement and reasonableness of the project price, instead of why the Navy is using one material over another, and so forth.

(2) The overall project risk is borne by NAVFAC. It could be argued that in reality NAVFAC bears the large majority of the project risk under the traditional approach anyway. Unforeseen site conditions, changed requirements, and design errors are the responsibility of NAVFAC on its existing projects, and NAVFAC is still the ultimate loser when a contractor falls way behind in his schedule or goes bankrupt, because the Navy is deprived of a facility's use for an additional period of time. NAVFAC has the potential to withstand project risk better than a general contractor. Even though a project may be large, NAVFAC with its large number of authorized jobs, $600 million appropriated annually, and centrally managed contingency funds, can withstand a cost overrun without destroying its program. On the other hand, to the general contractor the project represents a large segment of his volume and a cost overrun on that one project could destroy his company. The general contractor compensates for the high degree of risk he assumes by adding sufficient contingency to his bid to help him withstand adverse events. Statistically then, NAVFAC has a better chance of withstanding project cost overruns since over a large number of projects all over the world the overruns will be counter balanced by underruns. However, NAVFAC does face one big obstacle to truly flexible contingency fund management and that is the limit on cost escalation at any one Navy or Marine Corps installation of 5 percent. The individual project escalation limitation of 25 percent seems quite adequate and even the procedures for exceeding that, only involve sending a written notification to Congress where if not answered within 30 days, the request for exceeding that limit is considered approved.

Therefore, a real contributor to the risk burden of NAVFAC under this model is an arbitrary escalation limit of 5 percent set by Congress for the sum of all projects at any single installation. Recision of this constraint would greatly reduce the disadvantage that risk assumption presents to NAVFAC.

(3) Since there would be approximately 20 contracts on a project instead of one, there will be an increase in contract administration processing and paperwork. However, since this model (the commonly accepted break even point over which CM services are considered cost effective) would only be used for large projects over $5 million and since projects this size are a small minority of the total number of projects NAVFAC performs by contract, the impact on overall contract administration should be small.

(4) Even though this model provides for completion of construction as early as any system, including the existing one, the project may not qualify as a bonafide "construction start" within its program year which is defined as having 50 percent of the estimated construction cost under contract. This is because contract awards for this model are made at various times throughout the construction phase, whereas, the traditional approach with the lump sum award at the beginning easily qualifies as a "construction start." Since the level of within program year "construction starts" are used to justify funding levels for next year's program in Congressional hearings, this goal is quite important. The significance of this disadvantage may be reduced, however, if the criterion for a construction start was changed to perhaps the award of the first construction contract, the same Congressional requirement for preventing the expiration of the two year project authorization.

Even though the Model "B" alternative is the writer's first choice, it must be recognized that required changes, emitted as feedback in the thesis model presented in Section 1.10, must be made to the constraint "sieves" of the system. Inability to make these changes may dictate the usage of another alternative.

7.3.2 Second Choice

If, for example, (1) supporting documentation cannot be reduced thus requiring the continued use of an Early Design Cycle, and (2) the continuance of the 5 percent cost escalation limit on "same year" MILCON projects at individual military installations discourages NAVFAC from wanting to formally accept overall project risk, an alternative model may provide a better solution. Model D, the Guaranteed Maximum Price-CM, On-Site-OICC Pm, using an Early Design Cycle, may be more appropriate for this given set of circumstances. This is the model where the CM now accepts the financial responsibility should the project cost exceed an established ceiling price, NAVFAC's project management is performed on the job site, and the design is commenced two years prior to the time when construction funds are made available.

Many of the advantages of Model B given in the preceding subsection would be retained. Those remaining advantages would include:

(1) NAVFAC's ability to choose the head constructor

(2) The CM having to implement ideas he implanted into the design

(3) The reduction of uncertainty among contractors bidding on separate packages

(4) NAVFAC's ability to retain a CM with scheduling and management information and control expertise.

Model B's purported disadvantages of not providing supporting documentation and assuming the project risk would be eliminated. However, the following tradeoffs are required:

(1) The reduced effectiveness of initial market inputs since they are required two years before construction can start

(2) A reduction in design relevancy to facility user's needs and to the latest technology

(3) Reduced chances for personnel continuity

(4) Quality control (Q.C.) reverts to NAVFAC or it is performed by the CM in a similar manner to the existing CQC system. The CM's

financial interest in the project could now influence the effectiveness of his quality control program.

(5) The overall project cost should still be less than the existing general contractor system, however, NAVFAC must pay the CM for the cost of risk assumption.

(6) Since the project is committed to design at an early date, the chances are somewhat reduced that the project will survive all the levels of review and approval.

(7) The potential for reduction in the planning and programming cycle time is lost.

The disadvantages of increased contract administration workload due to multiple contracts for each large project and the inability to achieve the arbitrary "construction start" goal (50 percent of estimated construction cost in contract awards) still remain with Model D.

7.3.3 Third Choice

If the last two disadvantages cited in the preceding paragraph cannot be coped with or if the overriding preference remains strong for the concept of the single lump sum contract with the low bidding general contractor, there is still an alternative to provide some integration of design and construction. Model H offers a Construction Consultant to work in the design phase, with a Centralized Project Management organization, and an Early Design Cycle. Under this model a general contractor performs the construction in a traditional manner, NAVFAC's overall project management function is handled from their Engineering Field Division, and design commences two years before construction funds are received. This model eradicates all the disadvantages of Models B and C, however, it also contains none of the advantages listed for Model B. The overall project cost should still be less than a traditional project with no construction input to design since most of the savings generated on CM projects are purported to be made by way of these inputs. The fact that these inputs are made so far in advance of the construction phase and by a firm other than the general contractor who will have to direct their implementation, reduces the effectiveness of the inputs. However,

they will still produce a significant cost saving over the alternative of making no construction inputs whatsoever into the design.

7.4 Importance of Feedback Considerations

It becomes evident from Figs. 7.1 and 7.2, Table 7.1 and the discussion of this chapter that the selection of a contract construction procurement strategy is a complex decision. Even though three options were discussed in this chapter, the reader should note that these model systems are not ready for immediate implementation. It must be recognized that each of these models generates feedback to the environment in which Navy contract construction is performed and which is graphically illustrated by the thesis model presented in Section 1.10 These feedback considerations include such items as:

(1) Will the model make NAVFAC more responsive in meeting the construction requirement of the Navy in terms of the time that a facility requirement emerges to the day the user occupies the new structure?

(2) Will it be cost effective?

(3) What will be the effect on quality?

(4) Can constraints such as the 5 percent escalation limit and the criterion for a "construction start," be met or even changed?

(5) What would be the behaviorial reaction of the participants and particularly NAVFAC personnel? If negative, do the potential benefits of the model merit efforts to deal with and change their opinion?

(6) What internal organizational shifts and procedural changes must be made to maximize the benefits of the model?

The list of feedback considerations could go on and on. Any attempt to adopt one of the proposed models without determining the feedback effects could be disastrous. After the feedback effects are included in the earlier sections of the systems model, another pass through the model components should present a truer picture of the what the real outputs would be.

7.5 Summary

In this chapter a synthesis of the alternative CM concepts, PM organizations and cyclical strategies into model construction procurement systems has been made. The writer has ventured predicted results and effects of using these models based upon knowledge gained in researching this topic. However, the main contribution this chapter makes to the selection of a construction procurement system is not totally in the predicted results of using the selected models in Table 7.1 since the entire table is restricted by the biases and limitations of this writer. The main contribution is the framework Table 7.1 and Fig. 7.2 provide for an expanded analysis of a problem which is largely unquantifiable. Inputs from additional people who have a good working knowledge of a variety of procurement techniques can provide additional project and program aspects and/or new models which need to be considered. They can also provide their own predicted effects for existing and newly defined factors. In this way the views of numerous individuals concerning varieties of construction procurement systems can be brought out of the realm of generalization and into a model by model and item by item comparison from which the most adaptive system can be identified.

R E F E R E N C E S

[1]P. Kotler, Marketing Management, second edition, Prentice Hall, Englewood Cliffs, New Jersey, 1972, p. 475.

CHAPTER 8

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary

This chapter is the output or the last component of the thesis systems model introduced in Section 1.10. A quick review of the key points of the preceding chapters may provide a clearer understanding of these conclusions and recommendations.

In Chapter 2, it is evident that the goals of the Department of Defense and the Department of the Navy are of paramount importance and the benefits derived from actions in support of these goals is often non-quantifiable. However, the readiness environment of the military is often cast in conflict with the Congressional environment which supports a responsive armed force, but primarily stresses cost consciousness and equal treatment for contractors who do work for the services. Another element of the environment is the construction industry which is fragmented into small functional and specialized units and is sometimes characterized by inefficient management practices. A final element of the Navy construction environment is the organizational structure of the Naval Facilities Engineering Command which is designed to accomplish many other facility related functions in addition to design and construction.

In Chapter 3 it was learned that the planning and programming process for new facilities is very comprehensive, sophisticated and somewhat lengthy. The implementation process - the design and construction - is performed by the sequential technique of design, bid and construct. The portion of the Naval Facilities Engineering Command's organization concerned with the design and delivery of construction is organized in a manner which suits this traditional procurement approach.

On these traditionally performed projects, Chapter 5 indicated a sampling of large Navy projects required an average of 3-1/2 years for

design and construction. However, the design and construction time does not tell the entire story, because a project construction start date and eventual completion date are now a function of when the funds are appropriated by Congress. The large projects sampled showed some need for improvement in getting construction underway and completing at an earlier date. NAVFAC has responded to the need for getting construction underway sooner by trying to have as many designs as possible completed by the time construction funds are appropriated. In many cases, NAVFAC is starting designs two years in advance of the appropriation to achieve these earlier construction start goals. Also, NAVFAC projects showed some need for construction consideration in the design phase and for improvement in the quality control system.

In Chapter 4 the CM method was discussed from a number of angles to provide more specific information about CM and hopefully, remove some misconceptions about the system. It was pointed out that the CM replaces the general contractor, but CM is a much different contracting technique in that the constructor participates in the design phase and works on a professional basis with the owner/project manager. The CM system is well adaptable to owners with large facilities engineering and management staffs, because the method requires increased involvement on the part of the owner's organization.

Chapter 6 described how CM was instituted in two federal construction agencies to reverse the dreadful time and cost performance of their projects. Each agency, the General Services Administration and the Department of Health, Education and Welfare, uses conceptually different CM systems because of their different in-house project management organizations and methods of funding. The GSA's large, estiblished facilities engineering organization, the Public Building Service, allows it to dedicate a government project manager to each CM job and its Federal Building Fund provides it with flexibility of financial resources, so the "pure" CM approach is very applicable to this situation. GSA has the resources to assume the overall project risk and apparently has reaped the benefits of using this CM approach since the six CM projects completed

to date have all performed within the budget and averaged just over three years from start of design to completion of construction, which is down from the five years experienced under the traditional approach. HEW's limitations on project overruns and dispersion of funds to diverse owners in widely scattered locations requires them to exercise project control through the use of Guaranteed Maximum Price CM. Under this approach the CM has the financial risk and thus, an incentive other than his professional reputation to stay within the project budget. The key problem areas in the use of these new approaches have been

(1) CM's not performing up to the expectations of the owner/project managers, and

(2) lack of specific delineation of the CM's requirements by the owner/project manager.

In Chapter 7 a framework for analysis was presented which emphasized that analyzing the use of the CM alternatives must be done in a systems context. In this case, the system whose purpose is the procurement of contract construction for the Navy includes three dimensions:

(1) the CM concept

(2) the Navy's Project Management organization, and

(3) the cyclical strategy (or when the Navy should start design)

From these parameters fourteen model systems were presented and analyzed for their effect on project and program performance. All the models had positive and negative aspects, but three conceptually different systems were recommended in the order of their desirability. The first choice system, Model "B" from Table 7.1 used a Pure CM concept where CM's relationship to the Navy is purely professional. The second and third choices, Models D and H, used a Guaranteed Maximum Price-CM and a Construction Consultant (design phase participation only) respectively where the financial risk is borne by the CM or general contractor. The two other dimensions of each model, the Project Management organization and Cyclical Strategy, were combined with the corresponding CM concept to form a procurement system. None of the three selected were exactly

suited to the constraints of the existing system and each required different types of tradeoffs to achieve the benefits the model system offered. The constraints which had to be overcome for the most desirable system were more "fixed" than the ones of the less desirable systems. "Fixed" here, and as defined by the thesis model of Section 1.10, means the constraints are imposed at a higher level where it is harder to make a change. In the case of the first choice CM model, some Congressional constraints would have to be changed to realize the benefits of the model. The fact that Congressional requirements which constrain the first choice may seem somewhat arbitrary does not make them any less real.

8.2 Conclusions

Since Chapters 1 through 6 have presented elements of the systems and Chapter 7 introduced an extensive number of alternative model systems, the following conclusions will concentrate on the total effect of using CM and its related approaches.

Conclusion 1. Integration of design and construction can benefit the procurement of contract construction by the Navy. First, it is one of the major ways in which the Naval Facilities Engineering Command can become more responsive to the needs of the operating forces. If the design can be started later in the project life cycle, but still allow construction to start as soon as construction funds are available, which is possible through CM, some pressure will be taken off the planning and programming cycle. If improvements can be made to the planning and programming cycle, then the time from when a requirement goes into the "hopper" until the requirement is satisfied by a completed project can be reduced. This will have the side effect of reducing NAVFAC's risk to changed requirements of the proposed user and eliminate the need for frequent revalidation of the requirement. Further integration would not only increase responsiveness, but it would also maximize the utilization of available resources. Secondly, integrating methods like CM would satisfy the primary goals of Congress in that it would tend to produce lower cost projects, stimulate high levels of small business participation and comply with the required use of competitive bids. Thirdly, NAVFAC's

in-house organization would benefit from exposure to constructability inputs to design on large projects in that the idea and knowledge exchange may have some effect on smaller projects for which no formal construction inputs are provided. Finally, CM and other integration techniques are growing and many of the better engineering and construction firms which have produced high quality projects now offer this service.

Conclusion 2. The use of CM concepts would not create significant disruptions to the existing system. First, the CM uses the existing elements of the structurally fragmented construction industry such as small specialty contractors, and architects and engineers to optimize their collective performance. In fact, the CM approach may even help achieve some order when the economy is booming again and construction labor and material prices begin to rise so as to create uncertainty in the minds of bidders. Secondly, NAVFAC's basic organization will not change as a result of using CM except relatively minor adjustments are required to accommodate the appropriate PM alternative. This is important because the bulk of NAVFAC's construction work is on projects less than $5 million that will be accomplished through the traditional contracting method. Also, the chaos generated by substantial organizational change is avoided. Finally, the constraint changes which must be made by the Congress to accommodate the most desirable CM model do not appear significant. Changes to the 5 percent installation escalation limit and supporting documentation requirements which require technical aspects of each project be presented, would not alter the manner in which Congress reviews and approves the annual Military Construction program.

Conclusion 3. The disadvantages of using CM are outweighed by the advantages. The primary disadvantage is the overall project risk assumed by NAVFAC. However, when taking a "macro-view" of the Military Construction program and momentarily assuming the 5 percent installation escalation limit is not required, NAVFAC may more effectively assume the risk than a CM or general contractor. For example, a $10 million project to a contractor could represent 20 percent of his current volume. Thus,

he must charge NAVFAC a sufficient amount for contingency whereas this particular NAVFAC project may represent less than 2 percent of its entire annual Military Construction program. Statistically, NAVFAC with a larger resource base and a larger number of projects can withstand the risk better than a general contractor or CM and therefore, reap the resulting cost savings and if the disadvantages created by the Congress, such as the 5 percent installation escalation limit and the technical construction data required in the supporting documentation that are basically suited to the traditional procurement method could be changed, the major obstacles to CM would be dissolved. Without these constraints the potential advantages or time reduction, cost savings, improved quality control, and increased project control by NAVFAC could be realized by the implementation of a CM system.

Conclusion 4. The existing procurement system of NAVFAC is not presently suitable for the immediate use of CM in spite of all the potential benefits to be gained from using the system. Adjustments must first be made to:

(1) provide for the appropriate PM organization

(2) provide the appropriate cyclical strategy for design and construction

(3) remove the Congressional constraints which appear to be minor, but which would have significant influence on the success of the CM approach

(4) reduce the planning and programming time to fully realize time savings in the project life cycle

One exception is that a CM could be utilized by NAVFAC for emergency projects which are funded through reprogramming, or projects for which funds are immediately provided and for which no preliminary engineering work has been done. In these cases, construction usually needs to be completed at the earliest possible date so a CM phased constructed project would be highly appropriate.

8.3 Recommendations

Six basic recommendations are presented as a result of the research findings, and evaluation of the CM approach and its application to the Navy's system for construction procurement. The first four are in logical order of the steps to be taken for further research and study of the subject. Recommendations 5 and 6 are of a more general nature.

Recommendation 1. Since this thesis is only an exploratory study, a more in-depth and comprehensive study needs to be made into the cost and schedule performance of large Navy projects and CM projects for the General Services Administration and the Department of Health, Education and Welfare. The study of Navy projects could address the effectiveness of the Naval Facilities Engineering Command in meeting its user's requirements, needs and expectations plus evaluating the performance of more specific items such as

(1) Project Cost

(2) Project Life Cycle Time

(3) Effectiveness in Meeting Schedules

(4) Estimating

(5) Change Orders

(6) Quality Control

The expanded study of HEW and GSA could gather more specific data on the projects presented in Chapter 6 plus additional projects in both agencies. Hopefully, these studies would divulge more subjective information about governmental CM projects that was unavailable for this study. More specific information needs to be gathered about the impacts of CM on the owner/project manager's organization, the behavioral and attitudinal reactions of the project participants to CM, the quality of the job and the enforcement of warranty provisions. More in general information is required to determine the trend of the construction industry toward design-construction integration and the project value cut-off point below

which it becomes uneconomical to use CM. Implementation of this recommendation would actually represent the second pass through the thesis systems model of Section 1.10.

Recommendation 2. If CM still appears to be an attractive alternative, a study of the Navy planning and programming system should be undertaken with a goal of reducing the time between the point at which a routine project must go into the system and the point at which it must be presented to the Congress in order to be considered within a specific program year. The automation of the Shore Installations and Facilities Planning and Programming System which has taken place in NAVFAC in the last few years may help in reducing the slack time in some areas. If a significant reduction in planning and programming time is possible, then the use of CM becomes a highly attractive alternative.

Recommendation 3. If the CM alternative still has a potential attraction for Navy projects, the next step would be a test program. The test should include the use of one or more CM concepts with the corresponding PM organizations and cyclical strategies on a number of "routine" Military Construction projects. By using routine projects, procedures for the use of CM can be developed in a noncrisis environment. This is important since at this stage the Navy would still be at the beginning of the learning curve for CM utilization. CM procedures, contracts, control systems and other technology developed by GSA and HEW should be used to the maximum extent possible to minimize development costs to the Navy. GSA and HEW have learned a great deal about CM in the last few years and as a result they have made adjustments to their systems which could prevent owner/project managers new to the CM system from avoiding some of the same pitfalls. The test project must be staffed by a highly qualified CM and the requirements of the CM must be explicitly stated since these were the two main problems experienced in governmental CM systems and identified in Chapter 6.

It is important to emphasize that the results of the Navy CM projects should be measured both quantitatively and qualitatively. NAVFAC

should not take the precarious step of GSA and HEW who totally committed themselves to the use of CM on large projects without establishing any feedback mechanism to help measure program effectiveness. The results of these test projects should be evaluated in order to determine the true benefits and disadvantages of using a CM approach.

Recommendation 4. If the use of CM appears to be effective on the test projects performed by NAVFAC, then CM systems should be used for emergency and other high-priority projects since they are usually needed in a hurry and since it is likely that the construction funds have already been allocated before design even begins. The overlapping of design and construction on these types of projects can result in significant project time reduction. Enough NAVFAC expertise would have been developed by this point on the routine test projects to effectively cope with problems on the crisis jobs. Even if NAVFAC elected to continue the use of the traditional approach on normal Military Construction projects, CM could still be used on these emergency projects to cut project delivery time, plus it would give NAVFAC the flexibility to be able to adapt to a CM procurement approach should it become the dominant contracting technique.

Recommendation 5. Construction inputs to design can help NAVFAC projects now. Even the use of a construction consultant could provide cost saving inputs into the design at the present time. If a CM approach is later chosen for use by NAVFAC, the prior use of a construction consultant in the design phase of NAVFAC projects may serve to ease the adaptation period when CM systems are implemented.

Recommendation 6. If further consideration of CM is to be undertaken as recommended, then steps should be taken at an early date to continue studying the topic. To convert from the traditional approach to a CM approach may take a number of years considering the in-depth studies and test projects that should be undertaken to truly evaluate the system. The General Services Administration fully committed themselves to CM in 1970 and to date they have only completed six projects. Therefore, it will undoubtedly take time to conceptually alter a construction procurement system.

APPENDIX A

QUESTIONS POSED TO SENATOR JOHN TOWER CONCERNING THE MILITARY CONSTRUCTION PROGRAM

1. In examining a proposed Military Construction Budget, what are the key items you look for?

2. Do you measure the effectiveness of the services in implementing their respective military construction programs in terms of the amount of financial obligations made by each service against last year's authorized and appropriated funding level?

3. Does the Congress concern itself with following authorized and appropriated projects through to completion? Is effectiveness in this area examined?

4. Does Congress concern itself with the responsiveness of construction to fill a requirement? In other words, is the time lag between emergence of a requirement and completion of construction examined?

5. Are the supporting documents for proposed projects provided for you by the services satisfactory? Are they lacking in any areas? Are they providing more information than is necessary in any areas?

6. What do you consider are the main functions of the committees that examine military construction programs (programs' contribution to national security, protection of public funds, etc.)?

APPENDIX B

JOHN TOWER
TEXAS

COMMITTEES:
ARMED SERVICES
BANKING, HOUSING AND URBAN AFFAIRS
JOINT COMMITTEE ON DEFENSE PRODUCTION

United States Senate
WASHINGTON, D.C. 20510

August 18, 1975

James A. Broaddus, LT. CEC USN
1205 A Radcliff
Austin, Texas 78752

Dear Lieutennant Broaddus:

This is in response to your letter of August 13, 1975, requesting my views on various aspects of the military construction budget. For your convenience I shall answer your questions in their original order below.

1. The key items to look for in examining a proposed Military Construction Budget are the requirement by the Services for it, and its cost.

2. I am generally not concerned with measuring the effectiveness of the services in implementing the respective military construction programs, only with authorizations and appropriations.

3. The Congress does not generally concern itself with following authorized and appropriated projects through to completion unless there are problems requiring additional funding.

4. Again, the Congress does not concern itself with the responsiveness of construction to fill a requirement unless there are exhorbitant delays in construction as a result of poor conceptual design.

5. Yes, the services are satisfactory in their provision of supporting documents for proposed projects. No, they are not lacking in any areas. No, they are not providing more information than is necessary in any area.

6. The main function of the committees that examine military construction programs is protection of taxpayer's monies by austere, prudent funding of military construction essential to the defense of the country.

I hope this information is responsive to your needs. If you should need further clarification on some points please do not hesitate to contact me again.

Sincerely yours,

John Tower

John Tower

JGT:MHd

APPENDIX C

LETTER USED IN REQUESTING INFORMATION ON LARGE NAVY PROJECTS

3 September 1975

Dear

(1) The purpose of this letter is to request project data to be used in support of a Master's thesis in my postgraduate program at the University of Texas at Austin. My thesis will explore the suitability of using alternate forms of procuring construction to our traditional sequential technique of design, bid, construct for large projects. In order to effectively evaluate the impacts of any alternate system I need data and information on large MCON projects done under the "traditional" system. Your help in this effort would be greatly appreciated.

(2) The project(s) below was (were) selected from the EFD Field Execution Report (NAVFAC Report H7140R40). The project data in this report were inadequate and/or substantially confusing to prevent an adequate evaluation based on the report alone. These projects were selected because (1) the budget for the projects was in excess of $4,500,000, (2) they seemed to be executed in a traditional manner (design, bid, construct in sequence), and (3) they appeared to be either completed or substantially underway. The selected project(s) is (are):

MCON PROJECT #	FY	DESCRIPTION

(3) The following data are needed on each of the above projects:

	TIME DATA	ORIGINALLY PLANNED	ACTUAL OR LATEST PROJECTION
DESIGN	DATE DESIGN STARTED		
	DATE DESIGN COMPLETE		
CONSTRUCTION CONTRACT	DATE ADVERTISED		
	DATE BIDS OPEN		
	DATE OF AWARD		
	DATE FACILITY USABLE COMPLETE		

BID DATA

OF BIDDERS ______________ bidders

RANGE OF BIDS $______________ to $______________

GOV'T. ESTIMATE (for construction) $______________

AWARD DATA

AMOUNT OF CONSTRUCTION CONTRACT AWARD $______________

CONSTRUCTION DATA

OF CHANGE ORDERS (Actual or projected) __________ change orders

TOTAL AMOUNT OF CHANGE ORDERS (actual or projected $______________

COST DATA	actual or projected
DESIGN COST	$______________
CONSTRUCTION COST	$______________
SIOH COST	$______________
OTHER COST ________________	$______________

SUBJECTIVE COMMENTS (i.e., on quality; problems with the construction market (bidder interest, competition); "constructability" of design (practicality, cost effectiveness); contractor management/scheduling problems; material problems; etc.)

(4) If any of the above data are not available at your office, just leave it blank and I will chase it down. If you are aware of any projects that meet the criteria in Paragraph 2, I would appreciate data on those, too.

Thanks again for your cooperation.

JAMES A. BROADDUS
LT CEC USN
NROTC UNIT
UNIVERSITY OF TEXAS
AUSTIN, TX 78712

APPENDIX D

FY PROJECT YEAR	PROJECT NUMBER	PROJECT DESCRIPTION AND LOCATION	TIME DATA: DESIGN Date Started / Completed	DESIGN Duration (mos)	BID Date Advertised / Bids Open	BID Duration (mos)	Date Awarded	CONSTRUCTION Date Plan Compl. / Act/Final Com	CONSTRUCTION Duration (mos)	TOTAL DURATION (mos)	BID DATA: NUMBER OF BIDDERS	RANGE OF BIDS Lowest / Highest ($000)	GOV'T ESTIMATE ($000)	ESTIMATE VARIANCE (%)	AWARD DATA: AWARD AMOUNT ($000)	CONSTRUCTION DATA: CHANGE ORDERS Number	CHANGE ORDERS Amount ($000)	COST DATA: DESIGN ($000)	CONST ($000)	GOV'T SUPV/INSP OVERHEAD ($000)	OTHER ($000)
74	210	Bachelor Enlisted Quarters, Camp Lejeune, NC	20 Aug 72 / 27 Nov 74	13	30 Dec 74 / 17 Feb 75	3	23 Feb 75	Jul 76 / 2 Mar 77	20	42	5	6336 / 7032	7877	-24	6339	30	200	140	6336	N/A	N/A
75	747	Cold Storage Warehouse, Norfolk, VA	30 Dec 72 / 24 Oct 73	10	20 May 75 / 26 Jun 75	8	29 Jun 75	Oct 75 / Nov 75	20	47	3	4958 / 3274	4834	-3	5013	31	616	155	5013	342	119
73	587	Turbo Fan Acoustic Engine Test Cells, Norfolk, VA	N/A / 30 Aug 72	--	15 Nov 72 / 14 Jan 73	3	9 Feb 73	6 Dec 74 / 16 Oct 75	33	--	4	3108 / 3674	[illegible]	-7	3073	17	34		3102	404	1661
74	373	Berthing Pier, Norfolk, VA	20 Nov 72 / Mar 74	26	7 Apr 74 / 22 May 74	3	18 Jun 74	Mar 76 / Oct 76	28	47	3	7342 / 12294	8198	+8	7362	12	64	126	7906	396	1356
73	360	Bachelor Enlisted Quarters and Mess, Guantanamo Bay, Cuba	28 Jan 72 / 27 Feb 73	33	5 Aug 73 / 5 Oct 74	8	17 Oct 73	May 74 / 25 Oct 74	26	45	N/A	N/A	N/A	-	3297	8	471	--	3768	--	--
73	701	Aircraft Maintenance Hangar, Oceana, VA	13 Dec 70 / 8 Feb 73	26	24 Feb 73 / 25 Mar 73	3	24 Apr 73	Jul 74 / Nov 75	45	58	4	4902 / 4985	3236	+7	4902	21	222	172	5124	307	18
74	949	Applied Instruction Building, Dam Neck, VA	20 May 73 / 2 Jan 74	10	28 Dec 73 / 10 May 74	6	29 May 74	May 75 / Jun 76	25	36	3	5484 / 6196	5162	-6	5484	7	128	187	5612	323	3
74	036	Dispensary/Dental Clinic, Barbers Point, HI	29 Jun 72 / 12 Apr 74	10	26 Apr 74 / 26 Jul 74	4	2 Aug 74	20 Aug 75 / 30 Dec 75	17	23	5	5213 / 5943	3957	26	4822	11	100	787	4970	293	--
74	030	Bachelor Enlisted Quarters, [illegible], HI	3 May 74 / 3 Dec 74	7	13 Nov 74 / 27 Dec 74	1	31 Dec 74	Nov 75 / 1 Mar 76	10	22	4	6298 / 7390	6444	+4	6298	N/A	N/A	--	--	--	--
74	180	Electromagnetic Test and Analysis Fac., Navy Research Lab, Washington	10 Mar 73 / 24 May 74	14	2 Aug 74 / 16 Aug 74	4	13 Sep 74	Feb 76 / Jul 76	23	41	20	4607 / 5900	5230	+11	4709	16	200	200	4800	243	--
74	142	Bachelor Enlisted Quarters, Camp Pendleton, CA	9 Aug 72 / 19 Sep 74	25	14 Sep 74 / 5 Dec 74	3	20 Dec 74	Aug 76 / Apr 76	15	43	13	3731 / 6394	3907	+5	3731	--	--	--	--	--	--
74	077	Service Group Building, Navy Shipyard	8 Feb 73 / 15 May 74	15	23 Jun 74 / 27 Aug 74	3	27 Sep 74	Dec 75 / 13 Mar 76	18	30	10	7305 / 8812	6810	-8	7993	40	-230	336	22730	472	--
74	083	Sandblast and Paint Shop, Bremerton, WA	15 Feb 74 / 3 Nov 74	21	8 Nov 74 / 20 Dec 74	2	21 Dec 74	Sep 76 / 2 Oct 77	35	56	8	8053 / 7276	8017	1	8053	25	173	280	8230	370	--
74	432	Metal Preparation Facility, Bremerton, WA	23 Jun 73 / 6 Aug 74	14	23 Aug 74 / 13 Oct 74	3	13 Nov 74	7 Apr 76 / Mar 76	20	37	6	6097 / 6689	6844	20	5809	70	400	231	6208	348	--
74	--	Waterfront Improvements, San Diego, CA		--	18 Oct 74 / 19 Dec 74	--	21 Dec 74	May 77	29	--	8	20700 / 21363	17858	-16	20700	60	132	--	20827	1250	--
74	882	Naval Retirement Home, Gulfport, MS	25 Sep 72 / 14 Sep 73	23	18 Mar 73 / 28 Feb 74	7	3 Apr 74	Apr 76 / 22 Apr 76	24	63	7	13391 / 17064	10103	-33	12390	13	20	400	15931	--	--
77	600	Naval Hospital, New Orleans, LA	Apr 73 / May 74	23	Jun 74 / 3 Aug 74	5	23 Aug 74	Dec 74 / Dec 76	29	45	6	17283 / 17838	14761	-6	17253	100	220	741	17673	1035	--
74	036	Administration Complex, New Orleans, LA	Mar 73 / Feb 74	11	Feb 74 / 20 Apr 74	3	30 Apr 74	Jul 75 / 6 Jul 72	16	26	7	5299 / 5878	8000	+31	5744	90	1332	438	6631	610	--
73	613	Jet Engine Test Cells, [illegible], FL	Oct 72 / May 73	7	Jun 73	7	20 Jun 73	Aug 75 / Oct 75	28	36	N/A	N/A	N/A	--	5834	16	84	--	5918	--	--
74	900	Administration Building, Albany, GA	Jul 73 / Jun 74	13	20 Jun 74 / 4 Aug 74	2	9 Aug 74	Apr 76 / Apr 76	21	34	10	4227 / 6586	4804	+12	4237	3	60	223	4100	238	--
75	419	Machine Shop, Ship Yard, Charleston, SC	30 Apr 72 / 15 Apr 74	24	27 May 74 / 10 Sep 74	2	23 Sep 74	Jun 76 / Jul 76	22	37	3	4633 / 5062	4960	-2	4633	14	750	212	4472	299	27

APPENDIX E

GENERAL SERVICES ADMINISTRATION
PUBLIC BUILDINGS SERVICE

CONSTRUCTION MANAGER QUESTIONNAIRE

____
(Project name, location, and number)

FIRM DATA

1. PRESENT ORGANIZATION
If offeror is a joint venture, supply requested information on each involved firm.
   a. Firm.
      (1) Name, address, telephone, person to contact?
      (2) Name of parent company (if any)?

   b. Types of Services.
      (1) Construction management?
      (2) Project management?
      (3) General construction contracting, with building types?
      (4) Specialty construction contracting?
      (5) Design-build?
      (6) Architect-Engineer?
      (7) Combination, explain?
      (8) Other, explain?

   c. Legal Form.
      (1) Individual, partnership, corporation, joint venture, or other?
      (2) Date and location of establishment or incorporation under present name?
      (3) Former names, locations, and dates (if any)?
      (4) Names, titles, and addresses of firm owner, partners, or officers?
      (5) States and categories in which firm is legally qualified to do business?

   d. Branch offices.
      For each branch give:
      (1) City, state, and telephone number?
      (2) Number and type of personnel?
      (3) Person in charge?
      (4) Capability of performing independently of main office?

e. Operational Areas.
List geographic areas of the United States in which firm conduct business and value of construction work put-in-place during the past five years in each area?

f. Size.
(1) Present number and type of employees in home office, and in field offices (construction sites)?
(2) Number and type of employees during each of the past five years?
(3) Average annual receipts for the preceding three fiscal years

g. Facilities.
(1) Office space, equipment, and computers?
(2) Field facilities and equipment?

2. PERSONNEL
a. General.
(1) Policies?
(2) Recruitment, orientation, training, and development?
(3) Employee benefits and privileges?
(4) Employee relations?
(5) Employee average length of service?

b. Employee Qualifications.
Describe design oriented and construction oriented capabilities of personnel of your firm or joint venture, or consultants in the following areas:
(1) Job Cost Control,
(2) Architectural Engineering,
(3) Civil Engineering,
(4) Construction Superintendence,
(5) Contract Law,
(6) Electrical Engineering,
(7) Estimating (architectural, civil, mechanical, electrical),
(8) Construction Inspection,
(9) Labor Relations,
(10) Mechanical Engineering,
(11) Safety,
(12) Structural Engineering,
(13) Testing Facilities,
(14) Value Management,
(15) Management,
(16) Construction Management Control Systems,
(17) Computer Technology, and
(18) Other

c. Competence.
In what technical disciplines do you consider your staff to be exceptionally strong? Why? What are the names and specialties of the particular experts.

d. Design Contact.
Have your key employees been in personal contact with the designers or your construction projects during the design development? Extent and depth of the contacts?

e. Continuity.
(1) What is your capability to sustain loss of key personnel without adverse effect on a project or the firm?
(2) How do you minimize personnel shifts in projects?
(3) Recent history of key personnel turnover with dates, names of personnel and projects, and causes for changes.

3. CONSTRUCTION MANAGEMENT
a. Organization.
(1) Team, departmental, combination, permanent, temporary?
(2) Leadership and decision making?
(3) Top management involvement?
(4) Personnel recruitment, within firm or from outside?
(5) Number of personnel normally assigned to project during design, during construction, relationship to construction cost?

b. Planning.
(1) Initial
(2) Followup

c. Design Related Operations.
(1) Extent?
(2) Personnel involvement?
(3) Working procedures, coordination, followup, and cooperation with Contractors, A-E, and Owner?
(4) Inputting construction know-how?
(5) Market analysis?
(6) Interfacing construction contracts?
(7) Bid packaging and solicitation?
(8) Long range procurement?

d. Construction Related Operations.
(1) Extent?
(2) Personnel involvement, full, part time?
(3) Working procedures, coordination, followup, checking, and cooperation with Contractors, A-E, and Owner?
(4) Superintendence?
(5) Inspection?

(6) Technical support and consultants?
(7) Administration?
(8) Handling change orders, shop drawings, materials approvals, samples, as built drawings, and claims?
(9) Labor relations?
(10) Construction facilities, equipment, materials, and manpower?

e. Overlap of Design and Construction.
Describe your experience in managing phased construction activities, with particular emphasis on its special problems and their resolution.

f. Responsibility and Liability.
Discuss your review of the extent of your responsibility and liability as a Construction Manager under the proposed GSA contract.

g. Associations.
With respect to joint ventures or associations with other firms, please describe in detail previous associations on construction projects in sufficient detail to demonstrate your ability to effectively work with and manage a combination of firms. Indicate who the firms were if they are different from the ones proposed for this project.

h. Improvements.
What changes have been instituted in the last 5 years to improve your operations? Why were they needed? Have they been successful?

4. CONSTRUCTION MANAGEMENT CONTROL SYSTEM
Describe your firm's competence in the implementation and maintenance of network-based construction management control systems and in the application of systematic cost control methods. Give answers to the following:
a. Do you use computer generated schedules for construction management?
b. Do you require separate contractors to prepare their own schedules? Explain.
c. What is your experience in scheduling A-E activities?
d. What is your method of estimating construction requirements in pre-construction planning?
e. To what level-of-detail should a construction schedule be defined?
f. Which method of diagramming schedules do you normally employ, activity-on-arrow or precedence diagramming method? Explain.
g. Do you use cost-on-activities as a basis for control and/or payment?
h. To what extent do you rely upon the capabilities of your subcontractors to provide estimating know how?
i. Do you employ computer accounting systems in your work?
j. How do you use your computer systems to forecast work-in-place, manpower requirements, productivity, cash flow, and budget overruns?

k. What relationships do your narrative reporting systems have to your automated systems?
l. Have you ever employed GSA's construction management control system? Where? How? Results?

5. INNOVATION
Discuss your familiarity, involvement, and application of any of the following techniques or systems:
a. Project Management,
b. Conceptual Estimating,
c. Life Cycle Costing,
d. Specifications System,
e. Building Systems and
f. Value Management.

6. WORKLOAD
a. Present Projects. List (giving names of projects, locations, owners, estimated construction costs) work your firm responsible for, percent of design completion and construction completion, and firms associated with (if any).

b. Capacity. Describe in today's construction dollar the volume of work which your firm can handle at this time with a) your present force and b) with readily available augmentation (i.e. give number and types of additional personnel required).

c. Long Term Record. List in today's construction dollars, the volume of work your firm has handled for each of the past 5 years. Discuss reasons for any major fluctuations.

7. LOCAL KNOWLEDGE
Show recent knowledge and experience with local construction conditions in the proposed GSA project area.

8. PROCEDURES, CRITERIA, AND REGULATIONS
Discuss your familiarity with GSA's requirements based on your past experience.

9. SOCIO-ECONOMIC
Describe your experience with:
a. Energy Conservation,
b. Environmental Control,
c. Equal Employment Opportunity,
d. Small Business Utilization,
e. Utilization of Minority Businesses,
f. Employment of the Handicapped and
g. Other?

Contract No.________

10. FINANCIAL STATEMENT
    Attach statement of financial condition including regular dated statement or balance sheet.

11. REPUTATION
    Give name, address, telephone number, and person to contact for any of the following references you wish the Government to contact concerning your firms ability:
    a. Owners,
    b. Bonding Companies,
    c. Financial Institutions,
    d. Public Officials,
    e. Architect-Engineers,
    f. General Contractors,
    g. Major Subcontractors, and
    h. Major Suppliers.

PROJECT DATA

General Note. Base your written answers to the following searching questions on the actual experience of your firm or joint venture during the last five years. The replies should be detailed and informative, and cover all the facets of the questions.

12. PROJECT EXPERIENCE - GENERAL.
    Describe your experience on completed construction projects giving the following information on each project reported:
    a. Project name and location;
    b. Project description;
    c. Construction cost;
    d. Design start and completion dates;
    e. Construction start and completion dates;
    f. Actual work you performed;
    g. Owner's name, address, telephone number, and person to contact; and
    h. Architect-Engineer's name, address, telephone number, and person to contact.

13. PROJECT EXPERIENCE - SPECIFIC.
    For one or more of the above completed construction projects (maximum of three) which you consider similar to or equivalent to the proposed GSA project, provide the following additional information:
    a. Discuss any original or unique thinking or judgement exercised by your staff during the design development or construction;
    b. Number and subject of addendum issued during bidding; why they were needed;
    c. Number and subject of change orders issued during construction; why they were needed; and how they effected the construction progress;

d. The total construction award amount compared to the final prebid estimate;
e. Completed construction cost compared to the initial construction award amount and to the construction estimate when design was initiated;
f. The initial schedule in months for design and for construction compared to the actual time spent;
g. Extent of your involvement in project problems during both design and construction including any design or construction omissions, errors, other deficiencies, or changed conditions;
h. Discuss your relationships with the owner; the architect-engineer and the construction contractors (prime or sub);
i. Describe any post-construction problems in start-up, operation, or maintenance;
j. If you were doing the project again, would you do anything different? Why?

14. SIMILARITIES AND DIFFERENCES
In what way were your duties and services on the foregoing projects similar or equivalent to the services required in GSA's construction management contract? How were they different?

APPENDIX F

Revised: 4-15-75

LUMP SUM CONTRACT PRICE BREAKDOWN

Deliverables	Design (D) Phase	D & C Overlap Phase	Construct (C) Phase	Total
1. General Management	$	$	$	$
2. CMCS Narrative Reports				
3. CMCS Schedule Control				
4. CMCS Cost Control				
5. CMCS Financial Control				
6. Design Development/Review				
7. Long Lead Procurement				
8. Separate Contracts Planning				
9. Interfacing				
10. Construction Development/Review				
11. Final Plans/Specifications Review				
12. Market Analysis/Stimulation				
13. Solicitation of Bids				
14. Managing/Inspecting Construction				
15. General Conditions Management				
16. Safety Program				
17. Labor Relations				
18. Construction Changes				
19. Construction Claims				
20. Value Management				
TOTALS	$	$	$	$

Note: The D & C Overlap phase starts with award of the first separate construction contract and ends with award of the last separate construction contract.

V I T A

James Anthony Broaddus was born in San Antonio, Texas on August 4, 1947, the son of Burgess Anthony and Lucile Garrett Broaddus. After graduation from Alamo Heights High School in 1965 he entered the University of Texas at Austin where he earned his Bachelor of Science degree in Civil Engineering. Upon graduation he was commissioned into the Civil Engineer Corps of the U.S. Navy. His previous assignments have included the U.S. Navy Public Works Center, Subic Bay, Republic of the Philippines as Activity Civil Engineer to the U.S. Naval Station and Public Works Officer and Officer in Charge of Construction for the U.S. Naval Facility at Orange, Texas. In August, 1974 he was assigned to perform post-graduate study in Construction Management at the University of Texas at Austin. Currently he is a Lieutenant serving as an Assistant Resident Officer in Charge of Construction in San Diego, California. He is married to the former Kay Jean Holmes of Dallas, Texas and they have two sons, Scott Anthony and Jeffrey Jordan.

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